ENVIRONMENTAL MONITORING PROGRAM

Plan of Study

Shell Outer Continental Shelf Lease
Chukchi Sea, Alaska

May 2013

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ACRONYMS AND ABBREVIATIONS

ADCP...................acoustic Doppler current profiler
Ag.........................silver
Al..........................aluminum
ANIMIDA............Arctic Nearshore Impact Monitoring In Development Area
Ba ....barium
bbl/hr....................barrels per hour
Be ....beryllium
BOP......................blowout preventer
cANIMIDA ....Continuation of Arctic Nearshore Impact Monitoring In Development Area
Cd.........................cadmium
CFR ....Code of Federal Regulations
cm.........................centimeter
CoC ....chain of custody
COMIDA CAB ....Chukchi Sea Offshore Monitoring In Drilling Area: Chemical and Benthos
Cr..........................chromium
CSESP..................Chukchi Sea Environmental Studies Program
CTD......................conductivity, temperature, depth
Cu ....copper
DMP ....discharge monitoring program
DMR ....discharge monitoring report
EMP ....environmental monitoring program
EPA ......................U.S. Environmental Protection Agency
Fe..........................iron
ha ....hectacre
Hg.........................mercury
IC_{50}.......................inhibitory concentration that impacts 50% of a population
IHA ....Incidental Harassment Authorization
kg/m^2....................kilograms per square meter
LOQ ....limit of quantitation
m ....meter
m^2.........................square meter
mg/Kg ....milligrams per kilogram
mg/L.....................milligrams per liter
MLC.....................mudline cellar
mm ....millimeter
MMPA ....Marine Mammal Protection Act
MQO ....Measurement Quality Objective
NPDES.................National Pollutant Discharge Elimination System
OBS......................optical backscatter sensor
OCS......................outer continental shelf

OOC Model..........Offshore Operators Committee Mud and Produced Water Discharge Model
OSI.......................organic sediment index
PAH......................polycyclic aromatic hydrocarbon
Pb ....lead
PERF....................Petroleum Environmental Research Forum
PSO......................protected species observer
PTD......................proposed total depth
QAPP ....Quality Assurance Project Plan
QA........................quality assurance
QAU.....................quality assurance unit
QC........................quality control
ROV.....................remotely-operated vehicle
Sb ....antimony
SHC......................saturated hydrocarbon
SOP ....standard operating procedure
SPI........................sediment profile imaging
SPP.......................suspended particulate phase
TAH ....total aromatic hydrocarbons
Ti..........................titanium
TOC......................total organic carbon
TPH......................total petroleum hydrocarbons
TSS.......................total suspended solids
VOC.....................volatile organic compound
WBM....................water-based mud
WET.....................whole effluent toxicity
Zn ....zinc

1. INTRODUCTION

This document presents the environmental monitoring program (EMP) plan of study to be conducted at the discharge monitoring area within Shell Gulf of Mexico Inc. (Shell) Burger prospect lease blocks in the outer continental shelf (OCS) of the Chukchi Sea, Alaska, during and following exploratory drilling operations (Figure 1). The EMP presented in this document follows the stipulations presented in the *Authorization to Discharge under the National Pollutant Discharge Elimination System (NPDES) for Oil and Gas Exploration Facilities on the Outer Continental Shelf (OCS) in the Chukchi Sea, permit number AKG-28-8100* issued by the U.S. Environmental Protection Agency (EPA) in compliance with the Clean Water Act.

1.1. EMP Goal and Objectives

The goal of the EMP is to outline the sampling rationale and approach to collect high quality environmental data, during four discrete time phases, in order to support future permit development and to validate the determination that impacts from authorized Arctic offshore oil and gas exploration discharges will not cause an unreasonable degradation of the marine environment.

The objectives of the EMP, consistent with the NPDES authorization are:

1. Complete an initial site assessment, including a physical sea bottom survey, to ensure the exploratory facility is not located or anchored in a sensitive biological area or habitat;
2. Evaluate water quality characteristics of the receiving water and potential effects of the specified discharges;
3. Evaluate sediment characteristics of the seafloor and potential effects of the discharges on the sediment characteristics;
4. Evaluate potential effects to the benthic community structure due to deposition of Discharge 001 (water-based drilling fluids and drill cuttings) and Discharge 013 (muds, cuttings and cement at the seafloor), which includes both spatial and temporal changes in community diversity and abundance; and
5. Evaluate the suspended particulate and dissolved constituent plume(s) in the vicinity of the discharges.

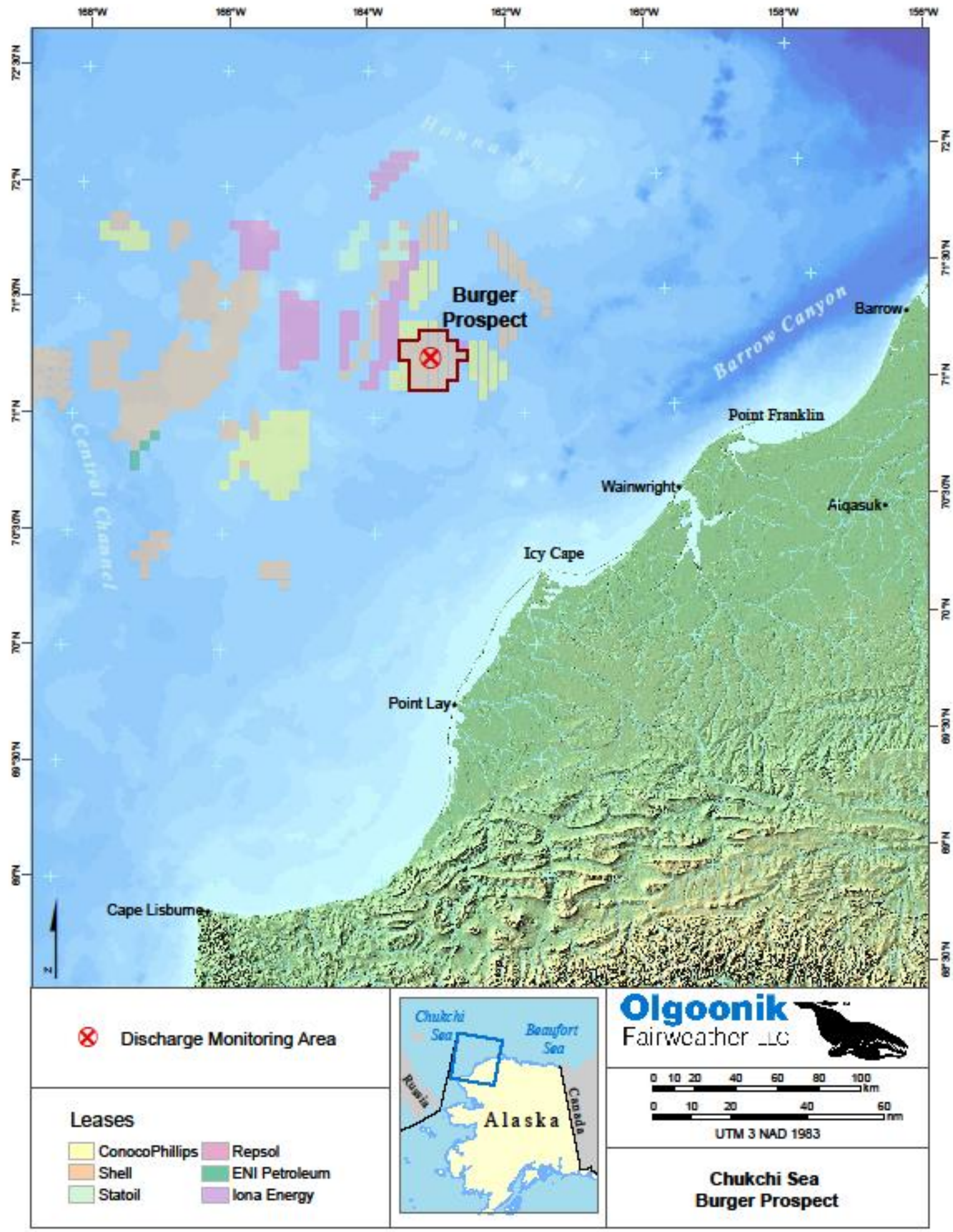

Figure 1: Chukchi Sea Burger prospect.

1.2. Authorized Discharges

A variety of waste streams are authorized under the NPDES permit, which includes 13 different discharges (Table 1).

Table 1: Summary of authorized discharges by number and description.[1]

Discharge Number	Description
001	Water-based Drilling Fluids and Drill Cuttings
002	Deck Drainage
003	Sanitary Wastes
004	Domestic Wastes
005	Desalination Unit Wastes
006	Blowout Preventer Fluid
007	Boiler Blowdown
008	Fire Control System Test Water
009	Non-contact Cooling Water
010	Uncontaminated Ballast Water
011	Bilge Water
012	Excess Cement Slurry
013	Muds, Cuttings and Cement at the Seafloor

[1]In the event that a particular discharge is not released, the requirements associated solely with that discharge will not be conducted

The discharges represent operational discharges resulting from normal drilling activities, such as sanitary and domestic wastes and desalination unit wastes (e.g., released from generation of drinking water), and discharges specific to drilling activities, specifically muds and cuttings.

2. BACKGROUND

Shell plans to drill several exploratory wells on the Chukchi Sea OCS in accordance with plans submitted to the U.S. Department of Interior. The predicted average drilling season is long enough to drill two or three exploration wells from spud to proposed total depth (PTD) and possibly construct an additional mudline cellar (MLC) or drill and secure a partial well.

2.1. Chukchi Sea Site Description

The OCS area of the Chukchi Sea is among the least-developed continental shelf areas in the United States. The Chukchi Sea is north of the Bering Sea and west of the Beaufort Sea, and borders numerous Alaska Native villages along the northwestern coast of Alaska (e.g., Wainwright, Barrow). The portion of the Chukchi Sea where oil exploration is intended is north of 70°N latitude (Figure 1). Both the Chukchi and Beaufort Seas were explored in the late 1980s and early 1990s for potential oil and gas development and have been further characterized in recent years following lease sales in 2005, 2007 and 2008. The location of the Chukchi Sea north of the Arctic Circle makes field work and data collection challenging, due to its remoteness, cold temperatures, and presence of sea ice for most of the year.

OCS Lease Sale 193 was held in February 2008 and Shell was subsequently awarded 275 leases (blocks) through a competitive bidding process. The locations of the lease blocks in the Burger Prospect and the drill sites addressed in this EMP are indicated in Figure 2. Water depth in this part of the OCS is shallow, ranging from 40- to 50-meters (m) deep. Predominant wind direction is from the northeast. Tides range from 5 to 30 centimeters (cm). Predominant water flow direction has been measured to the east-northeast, however weather conditions can be highly variable, with storms that result in significant wind-driven water surface currents in any possible direction. Due to the fact that the area is covered by sea ice much of the year, the exploration drilling and monitoring activities are anticipated to occur during the open-water season.

2.2. Chukchi Sea Drilling Operations

Currently, Shell plans to drill up to six wells to PTD in the Burger prospect using a drill rig. The drill rig will be attended by a fleet of support vessels, including roles for ice management, anchor handing, refueling, resupply and oil spill response. Table 2 lists possible drill site locations.

Table 2: Possible drill site locations in the Burger prospect.

Prospect	Well	Area	Block	Lease Number	Coordinates (m)		Latitude	Longitude
					X	Y		
Burger	A	Posey	6764	OCS-Y-2280	563945.26	7912759.34	N71°18’30.92”	W163°12’43.17”
Burger	F	Posey	6714	OCS-Y-2267	564063.30	7915956.94	N71°20’13.96”	W163°12’21.75”
Burger	J	Posey	6912	OCS-Y-2321	555036.01	7897424.42	N71°10’24.03”	W163°28’18.52”
Burger	R	Posey	6812	OCS-Y-2294	553365.47	7907998.91	N71°16’06.57”	W163°30’39.44”
Burger	S	Posey	6762	OCS-Y-2278	554390.64	7914198.48	N71°19’25.79”	W163°28’40.84”
Burger	V	Posey	6915	OCS-Y-2324	569401.40	7898124.84	N71°10’33.39”	W163°04’21.23”

2.2.1. Drilling Operations

Well drilling operations begin with the creation of a tophole. A tophole consists of the foundational hole section(s) drilled prior to installing a blowout preventer (BOP) stack. The design also includes a slim pilot hole to evaluate the site for shallow hazards and a self-supporting MLC. The MLC is drilled in such a manner as to create a subsurface space that is approximately 20 feet in diameter and 40 feet deep. This space is used to house the wellhead, casing, and blowout protectors and protect them from damage during ice gouge events. The precise configuration of casing and hole sizes, depths and supporting hole sections will vary as the well design is matured and optimized.

During the drilling of the tophole, drill cuttings will be deposited at the seafloor. During cementing of casing strings, spacer and cement will be deposited on the seafloor and/or on the bottom of the MLC.

After the tophole is completed, drilling is advanced through a BOP and marine riser. Drilling mud and cuttings are transported up the riser to the drilling unit. There the cuttings are separated from the drilling fluid by solids control equipment. The separated solids are discharged into the sea and the reclaimed mud is recirculated downhole.

After prolonged drilling, the drilling fluid properties degrade through exposure to high temperatures and pressures in the well and by dilution with water and clay-sized cutting particles. At that point, a portion of the drilling fluid in the mud tanks may be discharged to the ocean to allow for mud reformulation.

2.2.2. Mud Formulation

Shell plans to use water-based mud (WBM) as a drill-flushing medium. Due to the very limited environmental impact of WBMs, which have low toxicity characteristics (Neff 2010, Petroleum Environmental Research Forum [PERF] 2005), WBMs are an authorized discharge (001 and 013) under the NPDES permit for the OCS Chukchi Sea.

The primary purposes of drilling mud are to cool and lubricate the drill bit, remove cuttings, and maintain pressure and formation stability (Neff 2010). The mud is formulated to suit the nature of the formation being drilled, plus factors such as depth, temperature and pressure. As the borehole is advanced to its PTD, progressively more complex mud formulations may be used to control the properties of the drilling fluid, which is continually reconditioned and recirculated back down the drill string. Various additives are used to improve the properties of the drilling fluid such as density enhancers, fluid loss reducers, viscosity agents, lubricants, dispersants and shale reactivity inhibitors. Other additives may include biocides, oxygen scavengers and corrosion inhibitors. Specific details on the water-based muds to be used for the exploratory drilling in the Burger prospect can be found in the drilling fluids plan.

The ingredients of a typical water-based drilling mud include brine, fresh water, barite (barium sulfate [$BaSO_4$]), inhibitors and biopolymers. Agents such as barite are added to increase mud weight and counterbalance downhole pressures at depth. Small volumes of mud are periodically discharged in bulk and replaced with seawater to control the rheological properties of the fluid.

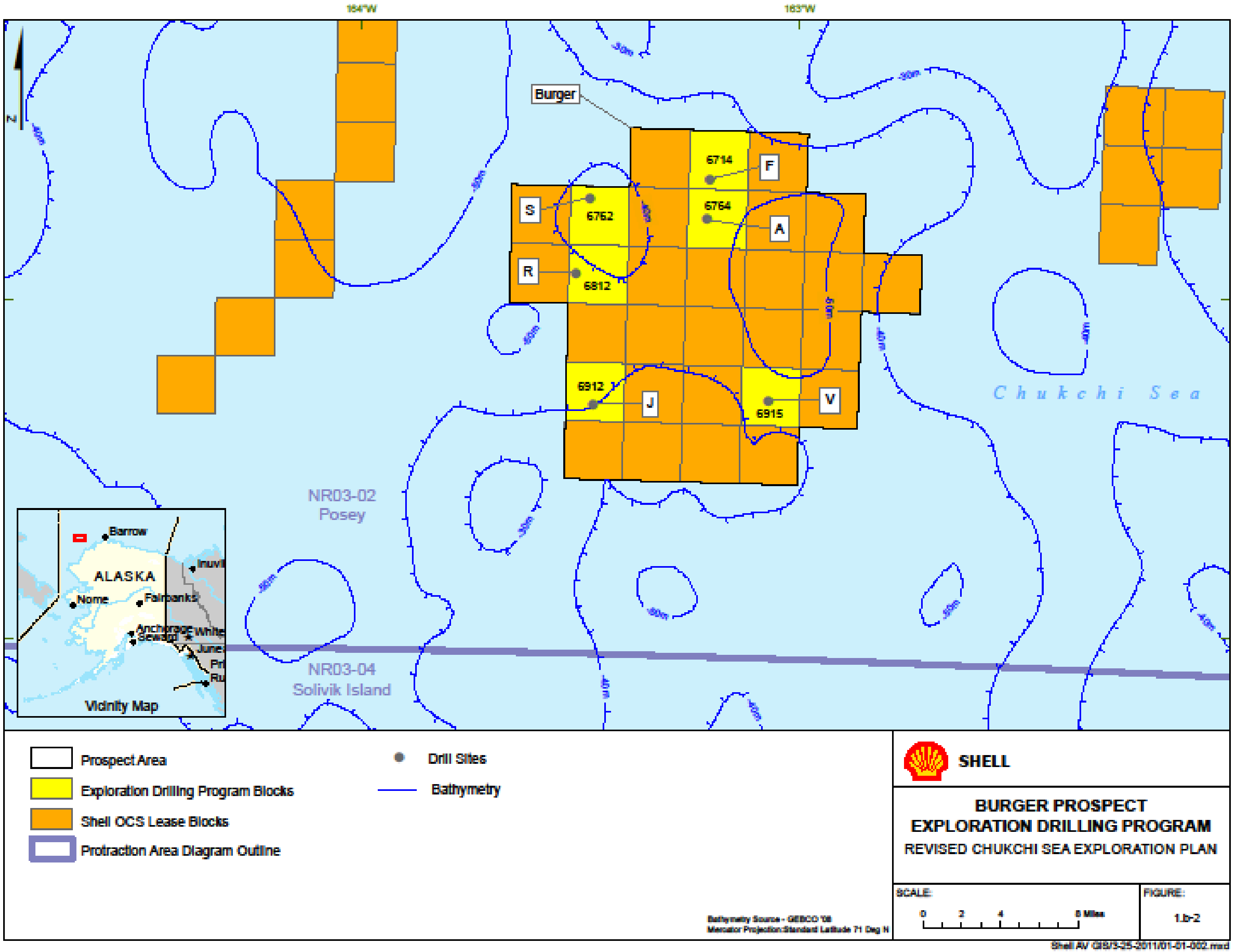

Figure 2: Burger prospect exploration drilling program.

Heavy metals such as copper (Cu), lead (Pb) and zinc (Zn) may be found in trace concentrations in drilling muds; however, these elements do not readily bioaccumulate (Neff 2010). Although the used mud could potentially contain various other additives, these materials represent only a small fraction of the overall mud volume (Neff 2008, Neff 2010). Most WBM additives are not bioavailable, are non-toxic, and/or are used in such small amounts that they are not present in used drilling fluids at concentrations high enough to contribute significantly to whole-mud toxicity (Trefry and Smith 2003, Neff 2008). The entire mud formulation goes through extensive toxicity testing and is verified to meet EPA's toxicity requirements (EPA 1993, EPA 2000, EPA 2006, EPA 2012, EPA 2013). The results of these toxicity tests are presented in the drilling fluids plan.

The manner in which the drill rig is operated and the nature of geological formations may contribute chemical constituents to the mud as the borehole is advanced vertically through the natural stratigraphic sequence. Once the reservoir target depth is reached, crude oil, condensate or gaseous hydrocarbons may become entrained in the mud. In samples of WBMs used in 2012, all metals were at or below background concentrations with the exception of barium (Ba), antimony (Sb), Cu, and Pb (Table 5). However, these metals generally are bound to clays or humates which limits their bioavailability. Similarly, hydrocarbons also typically exhibit limited bioavailability.

2.2.3. Discharge Streams

Anticipated drilling discharge streams from the drill rig are listed in the Notice of Intent. Muds and cuttings discharges do not occur continuously and are typically intermittently discharged during drilling operations.

During drilling, there will be a few bulk WBM discharges over varying time periods. These brief WBM discharges and the more frequent, lower-rate discharges of drill cuttings will be released about 6 m below the sea surface after dilution in the disposal caisson. Depending on prevailing oceanographic conditions, these discharges may or may not be visible from the rig or any vessels in the vicinity. The WBM and cuttings plumes will dilute to background levels downstream of the rig, mainly through the settling of drilling mud and cuttings solids onto the sea floor (Neff 2010).

The major drilling discharge will be drill cuttings. The cuttings consist primarily of inert solids, such as crushed rock, Ba, and bentonite clay that settle rapidly to and accumulate on the sea floor down-current of the rig. When discharged to the ocean, WBM and drill cuttings, which are slurries of particles of different sizes and densities in water containing dissolved inorganic salts and organic chemicals, form a plume that dilutes rapidly as it drifts away from the discharge point with the prevailing water currents (Figure 3).

The WBM discharge undergoes dispersion, dilution, dissolution, flocculation and settling in the water column. All components in the WBM and cuttings discharges are diluted many-fold during descent through the disposal caisson. Most dissolved components, such as sodium chloride, in the WBM or cuttings plume exiting the disposal caisson, continue to dilute rapidly by turbulent mixing (eddy diffusion) of the receiving waters (Neff 2010). Particles in the plume also dilute and are dispersed in different ways depending on their sizes and densities. The WBM and cuttings plumes are expected to partition into two phases: (1) a dense, rapidly-settling particulate solids phase (~90% of total mass of mud and cuttings solids), and (2) an upper-water-column, slowly-settling phase containing fine-grained (clay-size) particles and dissolved ingredients of the discharge (~10% of total mass; Neff 2010). Because of the shallow water depth at the drill sites and the distance between the bottom of the disposal caisson and the seafloor, the two plumes will be co-mingled, with the larger, denser particles settling to the sea floor nearer to the rig than the fine particles. Fine-grained particles (clays) in the upper plume will remain suspended at or below the discharge depth (the plume water will have a salinity and density similar to or higher than that of the ambient seawater) or settle slowly and be carried away in the direction of the mid-depth residual currents (toward the east. It is unlikely that the upper plume will rise into surface waters (upper 10 m).

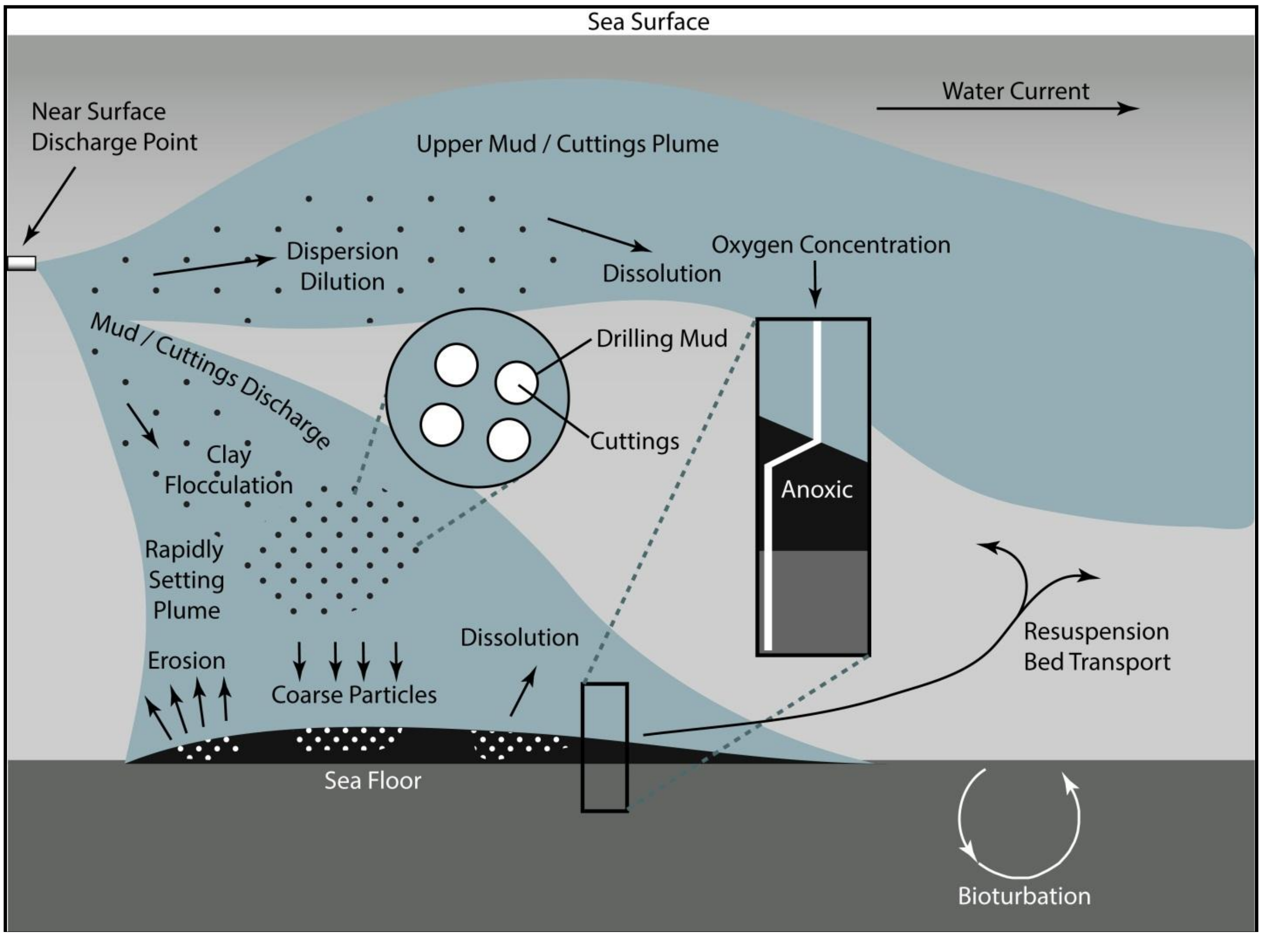

Figure 3: Dispersion and fates of WBM and cuttings following discharge to the ocean (Modified from Neff 2010). The WBM often forms 2 plumes, an upper plume containing fine-grained unflocculated solids and dissolved components of the mud, and a lower, rapidly-settling plume containing dense, larger-grained particles, including cuttings, and flocculated clay/barite particles.

The denser particles in the settling plume will sink quickly as they drift away from the discharge site, with the rate of sinking depending on particle size and density relative to seawater density at different depths in the water-column. The density of seawater increases with increasing depth (pressure) and salinity and with decreasing temperature. The continuous phase of both the gel WBM that will be used to drill the wider (upper) hole and the inhibitive polymer WBM that will be used to drill the narrower (deeper) sections of the well is a sodium chloride brine that will be denser than seawater; thus, the WBM plume will sink. WBM and cuttings particles may accumulate at a water depth where the density of the water and particles is the same.

2.2.4. Modeling Results

Environmental numeric modeling was conducted to simulate the dispersion and deposition of the cement, water based drill cuttings, and drilling fluids discharges using the Offshore Operators Committee Mud and Produced Water Discharge Model (OOC Model, Brandsma 2004 and Smith et al. 2004). The report, in its entirety, is provided as Appendix B to the EMP plan. The dispersion and deposition numeric simulations were performed for each well for six discrete drilling intervals divided into two discharge scenarios: sea floor and sea surface. Drilling intervals 1-3 are modeled as sea floor discharges and drilling intervals 4-6 are modeled as sea surface discharges. The sea floor discharges occur at 5 m above the seabed and the surface discharges occur at 6.7 m below the sea surface. The drilling operations are nearly identical for the three modeled wells (Burger A, J, and V) and are divided into six discrete drilling intervals.

The pre-diluted effluent discharge rates vary from a low of 15.9 barrels per hour (bbl/hr) to a high of 217.78 bbl/hr for six discrete drilling intervals for each well. Cement is discharged only for the sea floor discharge scenarios and is included in the volume of drill cuttings. The solids deposition on the seabed from the six discrete drilling intervals were compiled using a project post-processing tool of the OOC model yielding the total solids deposition loading and total thickness distribution on the seabed from the drilling operation at each well site.

The maximum total suspended solids (TSS) concentrations are: 10-100 milligrams per liter (mg/L) at 100 m, 5-10 mg/L at 200 m, and 1-5 mg/L at 500 m from the source. The maximum TSS values are 5 mg/L or less for five out of six drilling intervals at 200 m from the source. A summary of the discharge scenario and modeling results for Burger A is provided in Table 3.

Table 3: Discharge scenario and model predicted results for Burger A.

OOC Model Predictions													
Well ID	Discharge Scenario	Drilling Intervals	Duration of Drilling	Depth of Water	Depth of Discharge	Effluent Discharge Rate	Solids Deposition on the Seabed			TSS Concentration in Water Column (Distances from Source)		
							Area Covered by Solids Thickness		Maximum Deposit Thickness			
							> 1 cm	> 1 mm		100 m	200 m	500 m
			hours	m	m	bbl/hr	ha	ha	cm	mg/L	mg/L	mg/L
Burger A	Sea Floor	1	66.2	45.7	40.7	217.78	0.158	0.371	160.0	10 - 100	1 - 5	< 1
		2	5.2	45.7	40.7	190.78	0.086	0.117	19.0	5 - 10	1 - 5	< 1
		3	34.4	45.7	40.7	138.59	0.120	0.160	74.0	5 - 10	1 - 5	< 1
	Sea Surface	4	23.3	45.7	6.7	118.52	0.200	0.395	25.0	10 - 100	5 - 10	1 – 5
		5	29.0	45.7	6.7	61.67	0.182	0.340	15.0	10 - 100	1 - 5	< 1
		6	37.2	45.7	6.7	18.96	0.141	0.261	6.0	1 - 5	< 1	< 1
	Combined		**195.3**	**45.7**	**varies**	**130.22**	**0.245**	**0.594**	**262.0**	-	-	-
ha = hectacre mm = millimeters													

The model predicted total solids loading on the sea floor, as a result of the discharge of cement, drilling fluid, and water based drill cuttings, are estimated to be:

- Maximum deposit loading 11,387-11,600 kilograms per square meter (kg/m^2) occurs at the discharge location;
- Deposit loading is 1 kg/m^2 and 100 grams per m^2 at a distance approximately 300 m and 700 m, respectively from the discharge location; and
- The area affected by solids deposits loading of more than 1 kg/m^2 is approximately 9,220-10,390 m^2 or one hectare.

As an example, the total amount of deposition of solids for Burger A is shown in Figure 4.

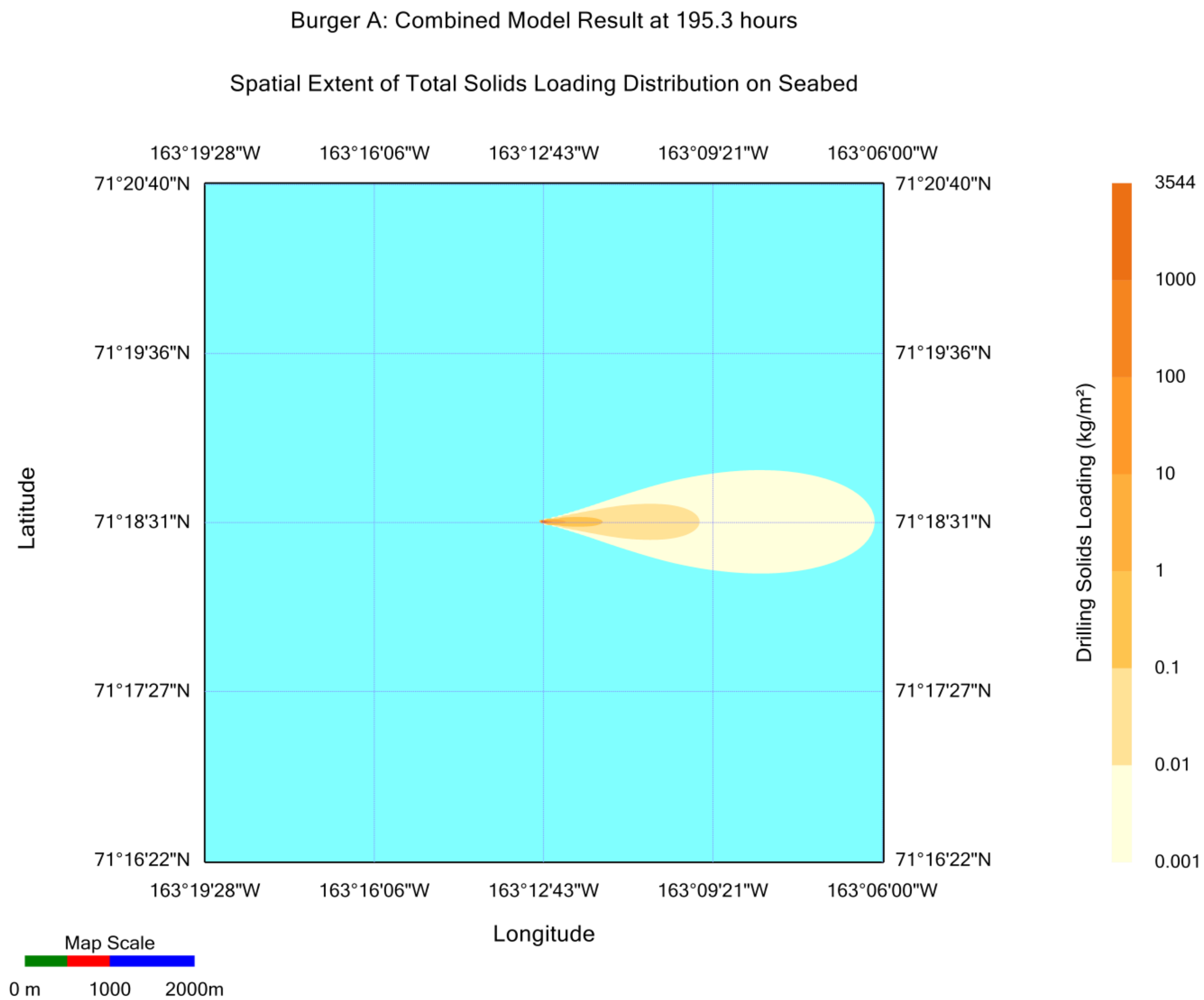

Figure 4: Total amount of deposition of solids for Burger A.

The model predicted total solids thickness deposited on the sea floor, as a result of the discharge of cement, drilling fluid, and water based drill cuttings, is estimated to be:

- Maximum deposit thickness of 859-872 cm occurs at close proximity to the discharge location;
- Deposit thickness is less than 10 cm approximately 60 m from the discharge location;
- Thickness is less than 1 cm beyond 120 m from the discharge location;
- Thickness is less than 1 mm beyond 250 m from the discharge location; and
- Thickness greater than 1 cm is limited to an area of approximately 1,460-1,570 m^2.

As an example, the spatial extent of total solids thickness on the seafloor for Burger A is shown in Figure 5.

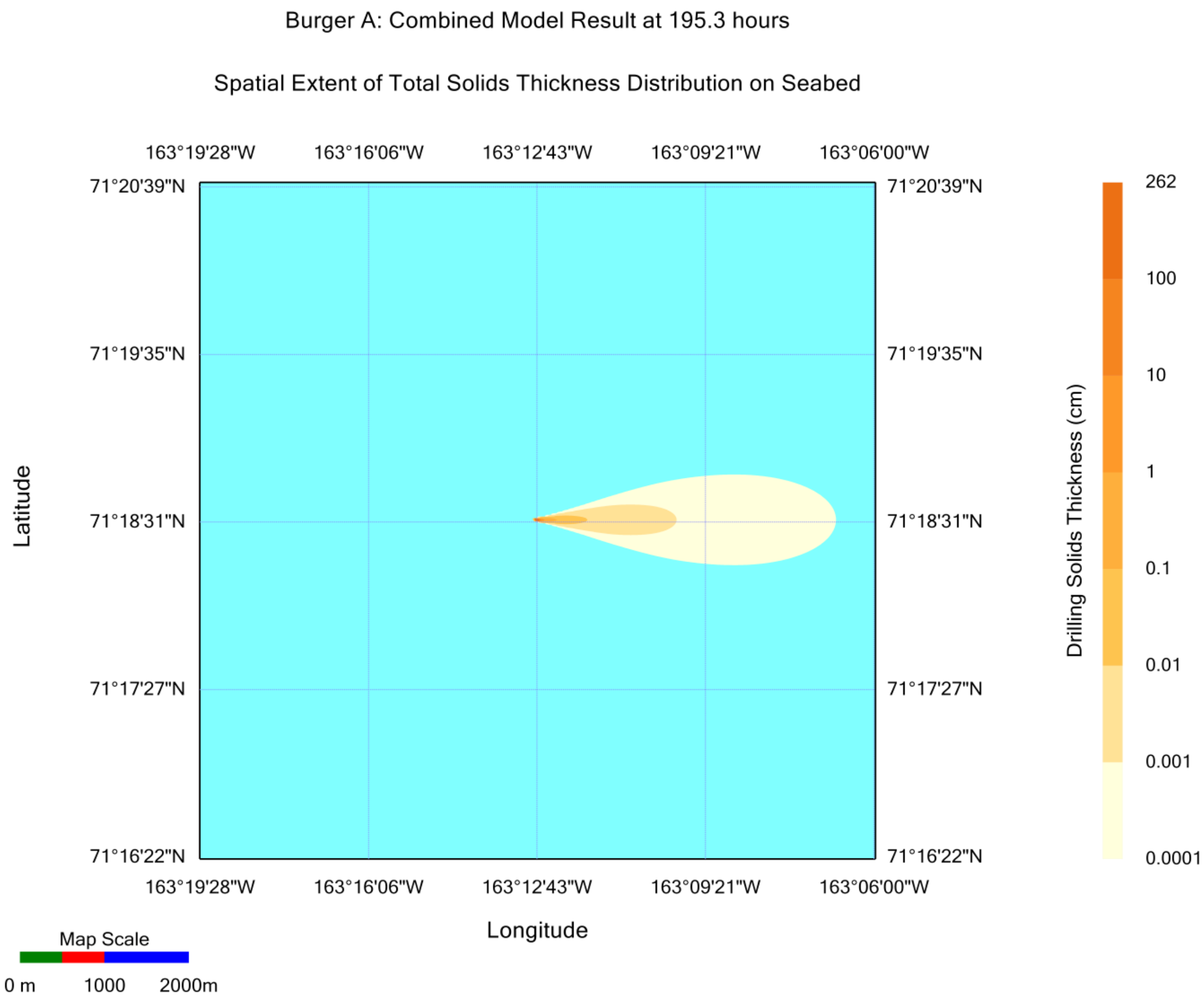

Figure 5: Spatial extent of total solids thickness on the seafloor at Burger A.

Total impact to the benthic environment from exploratory drilling at Burger A, Burger J and Burger V is estimated to be limited to an area of approximately 0.10 square kilometers (less than 2.5 acres). Impacts at 100 m from the discharge source are solids deposit thickness of 1 cm on the seabed and TSS in the range of 10-100 mg/L. Deposition beyond 200-250 m from the discharge source is insignificant: solids deposit thickness of 1 mm on the seabed and TSS of 5 mg/L or less.

The modeling results are based on the depositional dynamics expected for exploratory drilling discharges in the Chukchi Sea. Research based on empirical field measurements of metals and other chemical components associated with drilling activities corroborates the model results and demonstrates that the majority of the deposition of muds and cuttings typically occurs within 250 m or less from the discharge location (Trefry et al. 2013) and that discharge impacts are limited in time and space (The Research Council of Norway 2012, Trefry et al. 2013). This information was used in developing the technical approach and scope.

3. OVERALL TECHNICAL APPROACH AND SCOPE

The EMP sampling design and detailed scope of work, necessary to achieve the monitoring objectives, is organized into 4 assessment phases (I, II, III, and IV) as illustrated in Table 4.

Table 4: Summary of four phases for implementation of the EMP.

Phase	Component
I	Baseline site characterization
II	During active drilling
III	Post-drilling
IV	No later than 15-months after drilling operations cease at a drilling site

The Phase I assessment requires a physical site characterization which includes:

1. An initial site physical sea bottom survey;
2. Physical characteristics;
3. Receiving water chemistry and characteristics, and
4. Benthic community structure.

The Phase II assessment will be conducted during drilling activities and includes:

1. Effluent toxicity characterization;
2. Discharge 009 (non-contact cooling water) plume observations;
3. Water-based drilling fluids/drill cuttings metals analysis; and
4. Plume monitoring and observations.

Phase III and IV assessments are conducted following the cessation of drilling activities at a drilling site. Phase III components will be conducted as soon as practicable immediately after drilling and include:

1. Physical sea bottom survey;
2. Sediment characteristics and discharge effects; and
3. Benthic community bioaccumulation monitoring.

Phase IV assessments will be conducted no later than 15 months after drilling operations cease at a drilling site and include all components from the Phase III assessment with the addition of evaluation of the benthic community structure.

3.1. Phase I Assessment

The NPDES permit requires a baseline site characterization to be conducted as part of the Phase I assessment, but allows for data collected under other agency requirements or in a voluntary fashion, within the most recent 5-year period at or in the vicinity of the drill site location, to be submitted for consideration of meeting the requirement. The goal of this section is to present and demonstrate that sufficient baseline data exist throughout the northeast Chukchi Sea that can serve as a replacement for Phase I sampling at drilling locations within the Burger study area.

A substantial amount of baseline science and site characterization data exists for the Chukchi Sea OCS as a result of extensive, multidisciplinary research programs (both industry and government) that have been conducted during the past five years. Empirical data from the past five years exist for the Chukchi Sea from two large, comprehensive baseline studies that have been conducted annually for three and five years, respectively.

The Chukchi Sea Offshore Monitoring in Drilling Area: Chemical and Benthos (COMIDA CAB), a Bureau of Ocean Energy Management-funded study, collected chemical and benthic-ecology data for two years in 2009 and 2010. An extension of COMIDA CAB—Hanna Shoal Ecosystem Study—is a 2-year program begun in 2012 that has collected chemical and benthic-ecology data for one year. The COMIDA CAB sampling stations in the northeastern Chukchi Sea are shown in Figure 6.

The Chukchi Sea Environmental Studies Program (CSESP), a joint industry-funded study began in 2008 and has collected a diverse and multi-disciplinary dataset for the past five years. CSESP studies included environmental chemistry and benthic ecology, as well as physical oceanography, marine mammals and seabirds, and other disciplines. CSESP data were collected at three 30x30 nautical mile blocks (Klondike, Burger and Statoil). Only the Burger study area data (with some contemporaneous stations in the immediate vicinity of the Burger study area) are included here (i.e., Klondike and Statoil study area data are not presented) (Figure 6).

These comprehensive programs (i.e., COMIDA CAB and CSESP) provide a unique combination of government-funded and industry-funded data sets that, in conjunction, provide empirical data specific to the northeastern Chukchi Sea region, for the Burger prospect area, as well as specific drill sites such as the Burger A drill site.

In addition, a discharge monitoring program (DMP) was voluntarily conducted by Shell, in 2012, in which Phase I-equivalent data were collected at 18 stations around the Burger A drill site. The DMP stations represent spatially-intensive sampling points and are shown in Figure 6 (insets).

Information generated from these programs during the last five years, representing different geographical parts of the Chukchi Sea, was compiled and synthesized. Data analyses were conducted to determine variability within and among data sets from the same region and to establish that historical data from a larger geographical area may be predictive of current baseline data at site-specific locations.

A summary of the available baseline site characterization data is provided in Appendix A. This summary clearly demonstrates that existing information and data are sufficient to characterize baseline conditions for the components listed in section II.A.f. of the NPDES permit:

1. Initial physical sea-bottom survey;
2. Baseline physical characteristics (physical oceanography);
3. Receiving-water chemistry and characteristics; and
4. Baseline benthic-community structure.

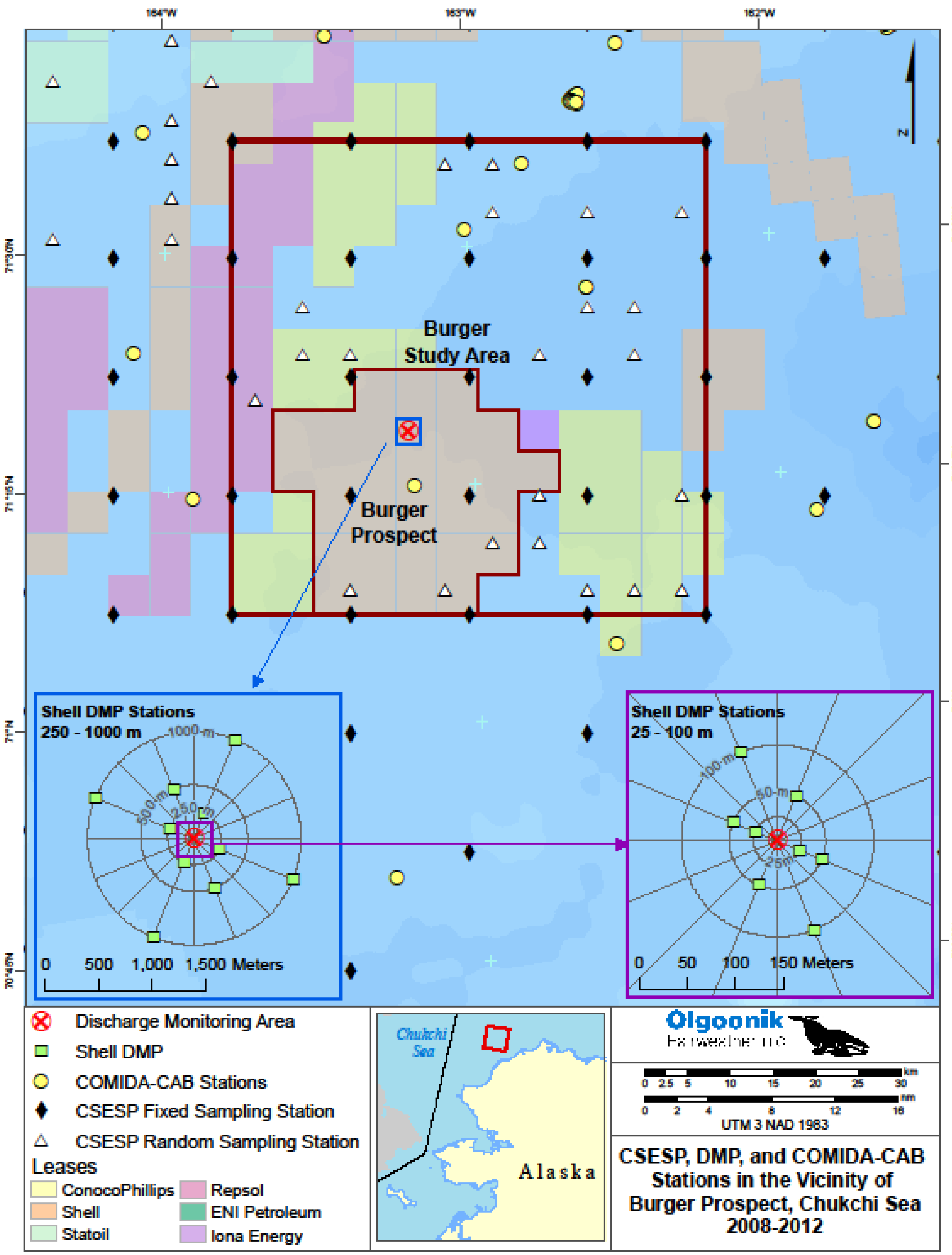

Figure 6: CSESP, DMP and COMIDA CAB stations in the vicinity of Burger prospect, Chukchi Sea, 2008-2012.

In addition, because water-based drilling fluids and drill cuttings (Discharge 001) will be discharged, the summary provides additional baseline data for the components listed in section II.A.13.j.2 and 3:

1. Sediment characteristics; and
2. Benthic community bioaccumulation monitoring.

Of particular note with respect to the Phase I pre-drill baseline data requirement, is the clarification regarding soft corals in the Chukchi Sea. News releases from 2012 suggest that sensitive species, specifically soft corals, were newly discovered in the Burger study area and are a critical habitat at the drilling location (http://www.greenpeace.org/usa/en/media-center/news-releases/Abundant-corals-discovered-at-Shells-Chukchi-drill site/). The soft coral in question, the Sea Raspberry (*Gersemia fruticosa* and *G. rubiformis*), is well known and widely dispersed throughout the North Pacific, the Bering Sea, Alaska's coastal waters, and the Chukchi Sea. Based on the extensive CSESP sampling from 2008 to 2011, there do not appear to be any habitats or species that can be designated as critical or unique in the Burger study area or specific Burger drill sites. Additional support for this conclusion can be found in the rejection of *Petition to list 44 coral species under the Endangered Species Act (ESA)*, published in February 2013 in the Federal Register (Federal Register, volume 78 number 31).

These existing data meet the Phase I data collection requirements and are submitted for consideration as Phase I baseline site characterization data for this EMP, as per the NPDES permit.

3.1.1. Revised List of Metals for Receiving Water Assessment and Justification

In accordance with the NPDES permit provision that "the permittee may propose an alternative list [of metals] based on site-specific data" (p. 21, OCS Chukchi NPDES permit), six selected metals from the suite of 19 for dissolved water analysis (NPDES permit, Table A, Metal contaminants of concern) will be removed from consideration as part of the receiving water chemistry (dissolved water analysis) assessment. The justification for removal of these six metals—aluminum (Al), iron (Fe), titanium (Ti), silver (Ag), antimony (Sb) and beryllium (Be)—falls into three categories:

1. Metals with extremely low water solubilities and/or are naturally at extremely low concentrations in water;
2. Metals that are present at or below background sediment concentrations in drilling-related products, such as WBMs and cuttings (e.g., Al, Ti, Fe, Ag, Be), Table 5; and
3. Metals with analytical challenges associated with measuring trace concentrations (related to extremely low water solubilities of particular metals) such that it would be difficult to tell the difference from sample contamination inherent in the process.

Table 5: Metal concentrations in stock barite and bentonite used for Shell 2012 Chukchi Sea exploratory drilling activities.

Metal	Bentonite Concentration[1] (mg/Kg)[n=1]	Average Barite Concentration[1] (mg/Kg) [n=3]	Average Chukchi Sea Sediment Concentrations[2] (mg/Kg)
Aluminum (Al)	9800	829	50,000
Antimony (Sb)	0.0961	7.9	0.62
Arsenic (As)	1.89	15.5	14.6
Barium (Ba)	2190	2373	591
Beryllium (Be)	1.78	0.133	1.2
Cadmium (Cd)	0.705	1.43	0.17
Chromium (Cr)	4.32	11.0	72
Copper (Cu)	8.94	82.2	14
Iron (Fe)	8050	10200	29,000
Lead (Pb)	37.3	124	11
Mercury (Hg)	0.124	0.522	0.032
Nickel (Ni)	3.19	10.0	25
Selenium (Se)	0.46 (U)[3]	1.03	0.74
Silver (Ag)	0.114	0.330	0.12
Thallium (Tl)	0.0698	0.113	0.41
Tin (Sn)	1.6	0.965 (U)[4]	1.4
Titanium (Ti)	78.5	13.4	(6,000)[5]
Zinc (Zn)	32.7	105	72

[1]Bentonite and barite analysis by method SW6020 (ICP-MS).
[2]Average Chukchi Sea sediment concentrations from Trefry et al. (2012).
[3]Selenium concentration in bentonite sample was analyzed for, but was not detected. Value reported represents limit of quantitation (LOQ).
[4]Tin concentrations in barite samples were analyzed for, but were not detected. Average value reported represents the averaged LOQ for three samples.
[5]Concentrations reported in parenthesis are estimated concentrations.
mg/Kg = milligrams per kilogram

The metals Al, Fe and Ti are major elements in sediments; however, all three have very low solubility in water and tend to adsorb on particles. For example, Fe concentrations are sometimes so low in the ocean that they have long been known to limit primary productivity (Martin and Fitzwater 1988). As such, particulate/suspended water concentrations are more informative for understanding concentrations of these metals in the discharge plume(s). Fe and Al can be useful particulate tracers and will be analyzed in particulate/suspended water samples.

The metals Ag, Sb and Be are present at extremely low (i.e., part per trillion) concentrations in water. Consequently, analysis of these metals in WBMs and cuttings will serve as confirmation that these metals typically are not recorded beyond background concentrations as a result of exploratory drilling operations.

Because the concentrations of these three metals are so low in water, the chance for accurate analytical results is low. These elements also are not toxic in seawater at concentrations well above natural values.

In summary, the following list of metals (Table 6) will be analyzed in dissolved water samples collected during Phase II monitoring. Note that sediments samples collected during phases III and IV will be analyzed for the full suite of metals listed in the permit.

Table 6: List of metals (13) for analysis of dissolved water samples collected during drilling monitoring.[1]

Arsenic (As)	Methyl Mercury (MeHg)
Barium (Ba)	Nickel (Ni)
Cadmium (Cd)	Selenium (Se)
Chromium (Cr)	Thallium (T1)
Copper (Cu)	Tin (Sn)
Mercury (Hg)	Zinc (Zn)
Lead (Pb)	

[1]In addition, the following metals will be analyzed in particulate form: aluminum (Al), iron (Fe), barium (Ba), chromium (Cr), antimony (Sb) and zinc (Zn), to augment plume monitoring assessment of metals.

3.1.2. Total Aqueous Hydrocarbons and Total Aromatic Hydrocarbons

Concentrations of hydrocarbons in water typically are very low and do not provide a representative evaluation over a temporal scale. In addition, sediment and tissue concentrations (as well as source samples, such as muds and cuttings) are more applicable for monitoring and assessing impacts of hydrocarbons in the context of exploratory drilling operations. Baseline hydrocarbon concentrations from recently collected seafloor sediments and biota tissue are provided in Appendix A.

Receiving water samples will therefore be collected during the Phase II (during drilling) component (rather than during a Phase I component) at reference stations in far-field areas located approximately 1,000 m from the drilling discharge location. These water samples will serve as contemporaneous reference samples for evaluation of receiving-water chemistry and characteristics and will be compared to the water samples collected in near-field areas during plume monitoring for hydrocarbon analyses. The comparison between the near-simultaneous collection of water samples, both within and outside of the discharge plume(s), will serve as a more robust means of determining differences between elevated hydrocarbon concentrations in the plume and the typical background hydrocarbon concentrations in Chukchi Sea receiving waters.

3.2. Phase II Assessment

The primary goal of the Phase II assessment is to characterize, to the extent possible, "physical and chemical concentrations throughout the discharge-affected water column and discharge plume." As per the permit, there are four monitoring requirements required in Phase II:

1. Effluent toxicity characterization;
2. Non-contact cooling-water (Discharge 009) plume observations for potential marine-mammal deflection during periods of discharge;
3. Water-based drilling fluids/drill-cuttings metals and hydrocarbon analysis; and
4. Plume monitoring and observations.

Of these four required components, effluent toxicity characterization and plume monitoring and observations require the most intensive sampling and analysis. Water-based drilling fluids/drill-cuttings analysis will provide empirical data on chemical concentrations present in these drilling components, which will help inform the analysis of samples collected during the plume monitoring component. The results from each of these four required components, taken together, help to evaluate any potential impacts from the activities, during the active exploratory drilling operations. The following sections describe in greater detail the scientific approach for each component. Based on the permit requirements, development of the initial toxicity screen is critical to effluent toxicity characterization because this toxicity screen will dictate whether whole effluent toxicity (WET) testing is triggered for certain discharges. The sampling design and conceptual approach for plume monitoring is also described in the following section.

3.2.1. Effluent Toxicity Characterization

Thirteen different discharge streams are defined in the general permit (AKG-28-8100) for the Chukchi Sea Oil and Gas Exploration (EPA 2013), six of which require toxicity characterization as part of the monitoring process for discharge compliance. The six discharges are deck drainage, desalination, boiler blow-down, fire control, non-contact cooling water and bilge. Table 7 provides a summary of each of these six discharge types and estimated number of samples that could be tested for each exploratory drilling well if all discharges were operational during drilling of the well.

Toxicity characterization will consist of an initial toxicity screening process using 100% effluent at four different time periods selected to reflect discharge practices and operational processes. If effluent samples fail the initial toxicity screen (as defined by the toxicity testing threshold limits established for this program), then WET will be conducted using three different species of organisms, including the topsmelt, *Atherinops affinis* (or *M. beryllina*, depending on availability), the mysid shrimp, *Americamysis bahia*, and the purple sea urchin, *Strongyocentrotus purpuratus*. The methods for WET are provided in established EPA procedures outlined in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine Organisms* (EPA-821-R-02-014 Fourth Ed.) and the *Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Water to West Coast Marine and Estuarine Organisms* (EPA/600/R-95-136).

Table 7: Example scenario of the maximum number of effluents collected and tested.

Discharge #	Discharge Description	# of Outfalls by Discharge type			Number of Initial Toxicity Screening Samples/Well	Operation of the Discharges
		Port	Starboard	Total		
002	Deck drainage	-	-	1[2]	4	Periodic discharge of effluent
005	Desalination	1	1	2	8	Continuous discharge of effluent
007	Boiler blowdown	-	-	1	4	Discharge of effluent is seldom and generates approximately 26.5 L; 61 L are necessary for initial screen and WET.
008	Fire control test	-	-	1	4[1]	Discharges effluent once a month
009	Non-contact cooling water	2	5	7	282	Discharges continuously except for the cement unit. Scheduling for the cement unit might require effluent collection during first event to conduct an initial screen and a WET series for three chronic tests (61 liters).
011	Bilge	-	1	1	4[2]	Discharges effluent intermittently but often enough to schedule Screening and WET
				Totals **13**	**52**	

[1]Multiple outfall locations are present; however, a sample port above the main header and representative of all downstream water will be used as the single testing location.
[2]Effluent samples are collected after the oil water separator.

Water quality conditions including temperature, salinity, pH and dissolved oxygen of each discharge type will be measured to confirm optimal testing conditions are created prior to the addition of test organisms. The process for adjusting effluent solutions to testing conditions is described in the laboratory section of this document. This process is required in the EPA-approved methods in order to adjust temperature, salinity or dissolved oxygen conditions to match the optimal conditions for each test organism. A brief description of each discharge type is provided within the context of toxicity testing considerations.

Discharge 002: Deck Drainage -- Deck drainage is the wastewater associated with washing platforms, decks, and equipment and runoff from curbs, gutters, pans and wash areas. The permit requires deck drainage systems separate drains associated with oil and grease wastewater from wastewater not in contact with surfaces containing any oil or grease. The wastewater associated with oil and grease drains are processed through an oil water separator to discharge into receiving waters. The effluent through this treatment system will be monitored using an initial toxicity testing screen. It is possible the deck drainage water will be fresh water in nature. The salinity of this discharge type will be measured and, if necessary, adjusted with brine solutions or artificial sea salts to testing conditions suitable for marine organisms.

Discharge 005: Desalination -- Effluent discharges associated with the creation of fresh water from seawater are likely to be high concentration brines similar to seawater in chemical composition but higher anion and cation ratios. Permit monitoring of desalination discharges includes initial toxicity screening. The potential high saline conditions of this discharge type may require a reduction of salinity to conditions that are conducive to test organism tolerance ranges.

Discharge 007: Boiler Blowdown -- The materials inside the boiler drums, including water and solids, are periodically discharged to minimize solids buildup in the boiler units. Monitoring of this discharge type includes an initial toxicity screen. It is likely this discharge will be fresh water and contain a large amount of solid materials. If necessary, the fresh water will be adjusted with brine solutions or artificial sea salts to salinity conditions conducive to test organism survival using the guidance provided in the EPA-approved methods.

Discharge 008: Fire Control System Test Water -- This discharge is created from seawater released during fire training exercises and testing and maintenance of fire protection equipment. Monitoring of this discharge type includes an initial toxicity screen.

Discharge 009: Non-contact Cooling Water -- Seawater is used as once-through cooling mechanisms for machinery on the drill rig and consists of the highest volume of discharge authorized under the general permit. For toxicity testing purposes, this discharge water may be at higher temperatures than are considered optimal for test species. The temperature and salinity of the non-contact cooling water will be adjusted to within testing parameters prior to the addition of test organisms.

Discharge 011: Bilge Water -- Bilge water drains into the drilling vessel hull and is processed through the oil water separator. The possibility of aquatic species may exist in this discharge. Effluent samples will be visually inspected using a light table to determine if organisms are present in the effluent. If organisms are observed, the effluent will be passed through a Nytex™ screen large enough to capture the organisms prior to the start of any testing.

3.2.1.1. Rapid Screening Test

The rapid screening toxicity testing process is designed to separate effluent discharge samples requiring further biological testing from those that do not. The main objective of the rapid screening process is to quickly focus on discharges more likely to result in adverse biological effects. Rapidity and sensitivity are two important features of the rapid screening test to demonstrate compliance with water quality goals. There are a number of biological methods that have been developed over the years, with exposure times ranging from less than 1 hour up to 96 hours. The most preferable screening tools for this effluent testing program are those that can be accomplished rapidly (<1hr). This criterion reduces the potential marine screening tools to the Microtox™ test and the echinoderm fertilization test. Table 8 provides general descriptions of potential screening tools, exposure period and method citation.

Table 8: Summary of selected rapid screening tools with exposure times of <24hr.

Test Name	Description of Test	Duration (hours)	Method	Reference
Microtox™ - water assay	Bioluminescent bacteria used to detect toxins. Amount of light emitted during exposure provides indication of toxicity compared to control.	0.25/0.50	(marine or freshwater)	Microbics Corporation 1992
Microtox™ sediment assay		0.25/0.50		
Echinoderm Fertilization-water assay	Echinoderm eggs and sperm are combined and the percent of fertilized eggs is an indication of toxicity compared to control.	0.40	EPA, 2002 - 1008.0 (marine)	Lee et al. 1999
Artotox	Brine shrimp exposed to effluent. Toxicity indicated by percent survival compared to control.	24	EBPI procedure (marine)	
QwikSed (dinoflagellate)-sediment assay	Bioluminescent dinoflagellates used to detect toxins. Reduction or inhibition in light used to indicate toxicity.	24	SeaLife Instruments, Florida (marine)	NFESC TDS-2077-Env, Feb 2000
QwikLite (dinoflagellate) - water assay		24		
Toxi-ChromoPad – sediment assay	Bacterium E. coli grown in solid material. If sample is toxic no color will develop. If sample is toxic a blue color develops.	1.5	EBPI procedure (freshwater)	Lee et al. 1999
Thamnocephalus platyurus- water or sediment	Freshwater crustacean exposed to effluent. Toxicity indicated by percent survival compared to control.	0.5 to 1		
Rototox – water or sediment	Rotifers exposed to effluent. Toxicity indicated by percent survival compared to control.	24		ASTM, 1991 E 1440-91

A comparison of the Microtox™ test and the echinoderm fertilization test was conducted by Environmental Canada (Buday 2001). The relationship between Microtox™ responses and the echinoderm percent fertilization success were not well correlated. The data from this study was graphically compared and is illustrated in Figure 7. Overall conclusions from the review indicate:

- Microtox™ responses in water exposures had no measureable responses for any of the samples tested.
- Microtox™ responses for the solid-phase test had significant reductions in light that occurred over a broad range from an inhibitory concentration that affects 50% of a test population (IC_{50}) of 526.9 to 13,080 mg/L (~25-fold).
  - Solid-phase Microtox™ responses occurred in samples that showed no significant response using the echinoderm test.
  - Acceptable echinoderm fertilization occurred over the entire solid-phase Microtox™ response range (526.9 to 13,080 mg/L) as shown by the blue shaded box in Figure 7.

- Conversely, negative responses from the echinoderm fertilization test showed a range of responses for the Microtox™ test with IC_{50} values occurring at <4,000 mg/L but not for all Microtox samples with these same response levels.

- There was no negative response for Microtox™ for the water exposure (this result was assumed to invalidate the test as an acceptable candidate for the NPDES permit program).

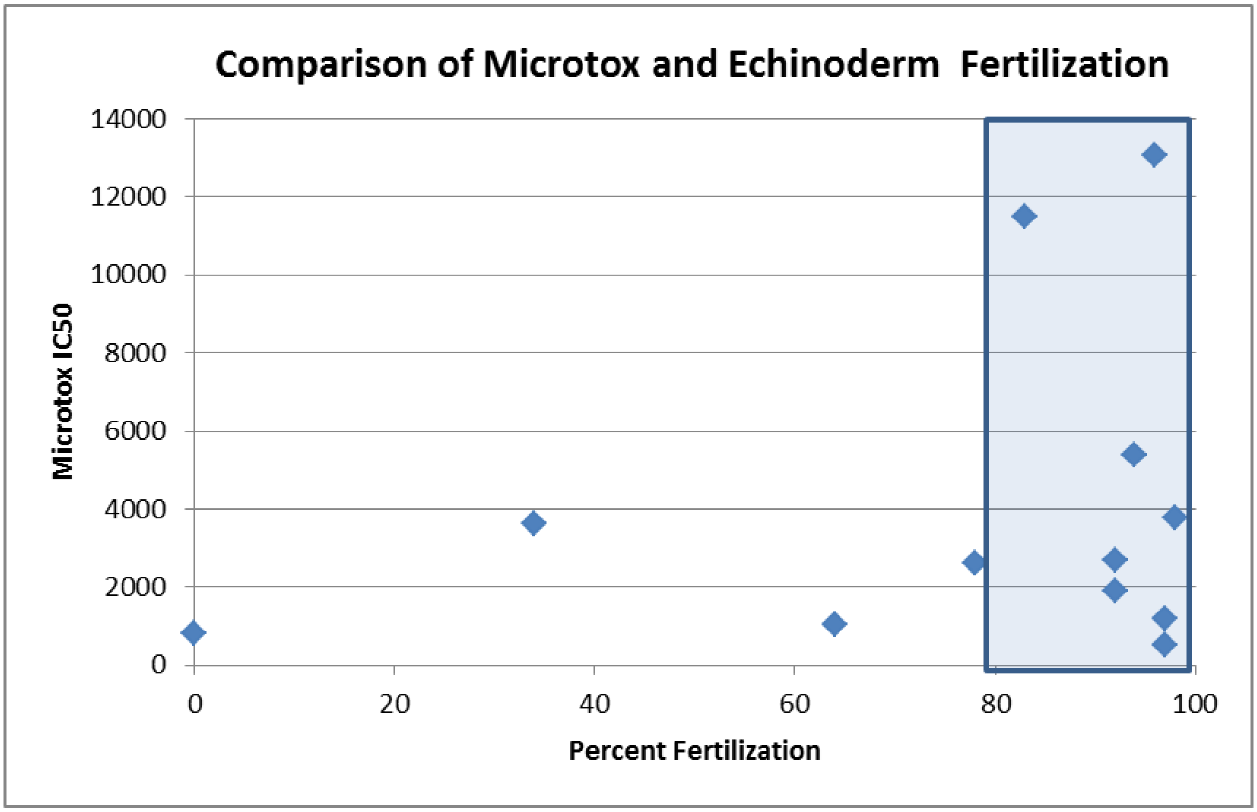

Figure 7: Graphical illustration showing inhibitory concentration that affects 50% of a test population (Microtox™) vs. percent fertilization in echinoderm fertilization test.

In addition to the observations by Buday (2001), a number of studies reported the interference of other environmental parameters, for example elemental sulfur, on the interpretation of the Microtox™ solid phase results (Jacobs et al. 1992, Pardos et al. 1999). Microtox™ responses in treated and untreated effluents were found to show similar results (Dorn et al. 1989). Water samples that contain surfactants at concentrations above a critical toxicity concentration were found to be unacceptable (Sherrard et al. 1996). Literature reviews of the apparent toxicity as measured by Microtox™ exhibit wide ranges. For example, Toussant (1995) found that metal toxicity measured by light output using Microtox (IC_{50}) varied by orders of magnitude (e.g., Zn 0.44 to 476 mg/L; Cu 0.076 to 25 mg/L; Cd 11.6 to 416 mg/L), with a small difference for unionized ammonia ranging from 1.49 to 2 mg/L. Similarly, NewFields (2009) conducted experiments to determine the influence of holding times on the amount of light output and found that the longer a sample was held within acceptable holding times and under acceptable temperatures the higher the incidence of effect on light output and that these results appeared associated with sulfides and ammonia.

Based on the comparison results provided above, the echinoderm fertilization test will be used as the rapid screening tool for this EMP. Unlike Microtox™ test responses, screening with fertilization tests using echinoderm gametes correlates well with other test organism responses. The fertilization test results also show a strong relationship to exceedances of contaminant guidelines for metals, ammonia and polycylic aromatic hydrocarbons (Carr et al. 1996). Test results are ready to be counted within one hour of exposure and yields results that can be interpreted relative to contaminants of interest whereas the Microtox™ test responses may have interferences from extended holding times and fluctuating sulfide and ammonia conditions. Three echinoderm species will be included in the testing guidelines for the NPDES in order to meet windows of reproductively appropriate time frames. The species would include the sand dollar (*Dendraster excentricus*) and the sea urchins (*Strongylocentrotus purpuratus* and *Lytechinus anamesus*). The echinoderm fertilization test is an EPA-approved method (EPA/600/R-95/136).

If the initial toxicity screening test indicates the effluent response is below the biological threshold or if discharge limits are exceeded as specified by 10,000 gallons in a 24-hour period and if chemicals are added to the system, additional WET will be conducted following established EPA methods as described in section 3.2.1 of this document. The screening level toxicity testing results will be reported within the discharge monitoring report (DMR) for the month following the sample collection. The WET testing results will be reported in the DMR that occurs at least two weeks after the completion of the WET testing. The methods for WET testing, which include 7-day Topsmelt larval and survival growth test, 7-day Mysid shrimp survival, growth, and fecundity test, and a 72-hour Purple sea urchin larval survival and development test, are well established. Additionally, EPA standard operating procedures (SOPs) already exist for each test, thus the toxicity thresholds associated with all of the WET testing components are already defined by these existing, validated methodologies. Consequently, WET testing toxicity thresholds are not criteria that Shell is tasked with defining (unlike for the initial toxicity screening). Additional information and detail on WET testing can be found in the project specific quality assurance project plan (QAPP).

3.2.2. Non-contact Cooling Water (Discharge 009) – Marine Mammal Deflections

Shell operates an extensive integrated marine mammal monitoring program in compliance with the Marine Mammal Protection Act (MMPA) during all exploration activities. In accordance with the MMPA, applicants for an Incidental Harassment Authorization (IHA) from the trustee agencies, i.e., National Marine Fisheries Service and U.S. Fish and Wildlife Service, are required to provide a monitoring and mitigation plan. The agencies evaluate these plans through a process of independent peer review and public review prior to authorizing proposed activities. Although the IHA that will cover proposed 2014 drilling operations along with the associated monitoring program is not yet available, it is anticipated that the monitoring program will be effectively the same as the one implemented in 2012. A full description of this program and its results can be found at http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_90dayreport_draft2012.pdf.

In summary, the Shell monitoring and mitigation program includes three integrated components:

1. A vessel-based observer program under which protected species observers (PSOs) on all vessels maintain watch for marine mammals. These PSOs have dual duties to implement any needed avoidance or mitigation measures and to record data on observations, including species, location, activity, orientation toward drilling activities, etc.;
2. An aerial based observer program under which PSOs fly over the area of the drilling activities and observe and record data on marine mammals; and
3. An acoustic program under which industry sounds and marine mammal calls are recorded and can be analyzed for distribution and reaction to drilling related activities.

This integrated program will provide a good understanding of the relative distribution of marine mammals in proximity and relation to the drilling related activities, the relative amount of time individuals may be within an area of potential exposure, and the portion of the population of each species that could potentially be within a range of exposure to drilling related effluents.

Thermal dispersion modeling indicates no significant impact on ambient water quality in the vicinity of the drill rig. The maximum plume depth derived from the model is 3 m. The maximum plume width is 15 m, and the maximum thermal plume duration is 30 minutes. The maximum area affected is 45 m^2 (Appendix C).

3.2.3. Water-Based Drilling-fluids/Drill-cuttings Metals and Hydrocarbon Analysis

Samples of WBMs and drill cuttings will be collected during the drilling operations at the time of maximum potential contamination—anticipated to be at the end of the well—by an on-rig compliance engineer and then transported to the relevant analytical laboratories to be analyzed for metals and hydrocarbons. Modern WBMs have a limited number of ingredients, and have low toxicity designed to comply with environmental regulations (Neff 2010). Modern WBMs no longer contain metal constituents, such as Sodium Bi-chromate (contains Cr-6), that historically were used in drilling activities. The EPA has also established stringent guidelines on Hg and Cd limitations. These guidelines have been effective at limiting concentrations of those metals (and other co-occurring metals) in WBMs. Changes to pipe-dopes and the limited use of additives also have resulted in lower concentrations of metals present in drilling fluids (Neff 2010). Concentrations for most metals present in WBMs typically are within the range of concentrations present in uncontaminated marine sediments (Neff 2010). The one exception is Ba, which due to its role as a weighting agent, is present in higher concentrations.

Although only metals analyses are required in the permit, hydrocarbon analyses will also be conducted to serve as source samples that will inform data-analysis components in post-drilling phases (phases III and IV). Hydrocarbons are not typically present in WBMs, but may become entrained in muds when penetration of the hydrocarbon zone occurs during exploratory drilling.

3.2.4. Plume Monitoring and Observations

The objective of the plume-monitoring task is to identify the plume(s) resulting from the discharge of drilling muds and cuttings (Discharge 001) and measure "metals, organics, turbidity and total suspended solids throughout the water column" during periods of maximum discharge. Additionally, the objective is to focus characterization efforts to areas of expected deposition of muds and cuttings based on model predictions. Plume monitoring will also serve as a check / verification of modeling of effluent behavior.

Phase II plume monitoring will be conducted on a vessel provided by and under the control of Shell. The vessel will be tasked with other duties but will be made available for plume monitoring for several days during the period when drilling discharges take place. Safety, operational and navigational issues could limit the ability to delineate plumes in the immediate vicinity of the drilling operations. Within these logistical constraints, an effort will be made to locate and sample the plumes originating from the drilling vessel over the various stages of drilling the well.

The following time points during drilling will be targeted to capture the "maximum discharge periods" and periods representing different types of discharge (i.e., potentially different physical and chemical composition of the discharge):

- Largest casing interval (beyond top-hole);
- Hydrocarbon zone; and
- Bulk-mud discharge (if this occurs).

During the three discharge events listed above, seven sampling stations will be targeted for sample collection. An illustration of the Phase II plume sampling stations is provided in Figure 8. Six sampling stations will be located along three transects (two stations per transect) oriented in the direction of the predominant current. The three plume transects will be separated approximately 10-15 degrees from the source. All plume-transect sampling stations will be located within 500 m from the drilling location, with the near-field stations being as close to the discharge as logistically possible. A seventh sampling station will serve as a reference station and be located at least 1,000 m away and perpendicular to the northern end of the downstream plume transect.

The geometry of a discharge plume is directly influenced by the ambient meteorological and physical oceanographic conditions in the vicinity of the well site. Current speeds and turbulent mixing zones at different depths in the water-column can have a substantial effect on the dispersion and deposition rates of particles. Currents within the area of the drill rig are horizontally coherent over distances of 10 to 20 kilometers (T. Weingartner, personal communication); therefore, the location, transport and fate of mud and cuttings plumes will be monitored by using water column velocity data from an acoustic Doppler current profiler (ADCP) and a deployable water column profiler. An ADCP with real-time or near-real time data-transfer capability will be located on, or in the vicinity of, the drill rig to provide information on near real-time currents. Water column velocity data from the ADCP will be used in near real-time to coordinate the deployment of a water column profiler, a Sea-Bird Electronics, Inc., SBE19 (or equivalent) conductivity, temperature, depth (CTD) unit equipped with two turbidity sensors, an optical backscatter sensor (OBS) and a transmissometer. Data from the turbidity sensors, indicating potential discharge of suspended solids, will be used to obtain near real-time multi-dimensional data on water column conditions. Weather data will be acquired in the field to further inform sampling activities.

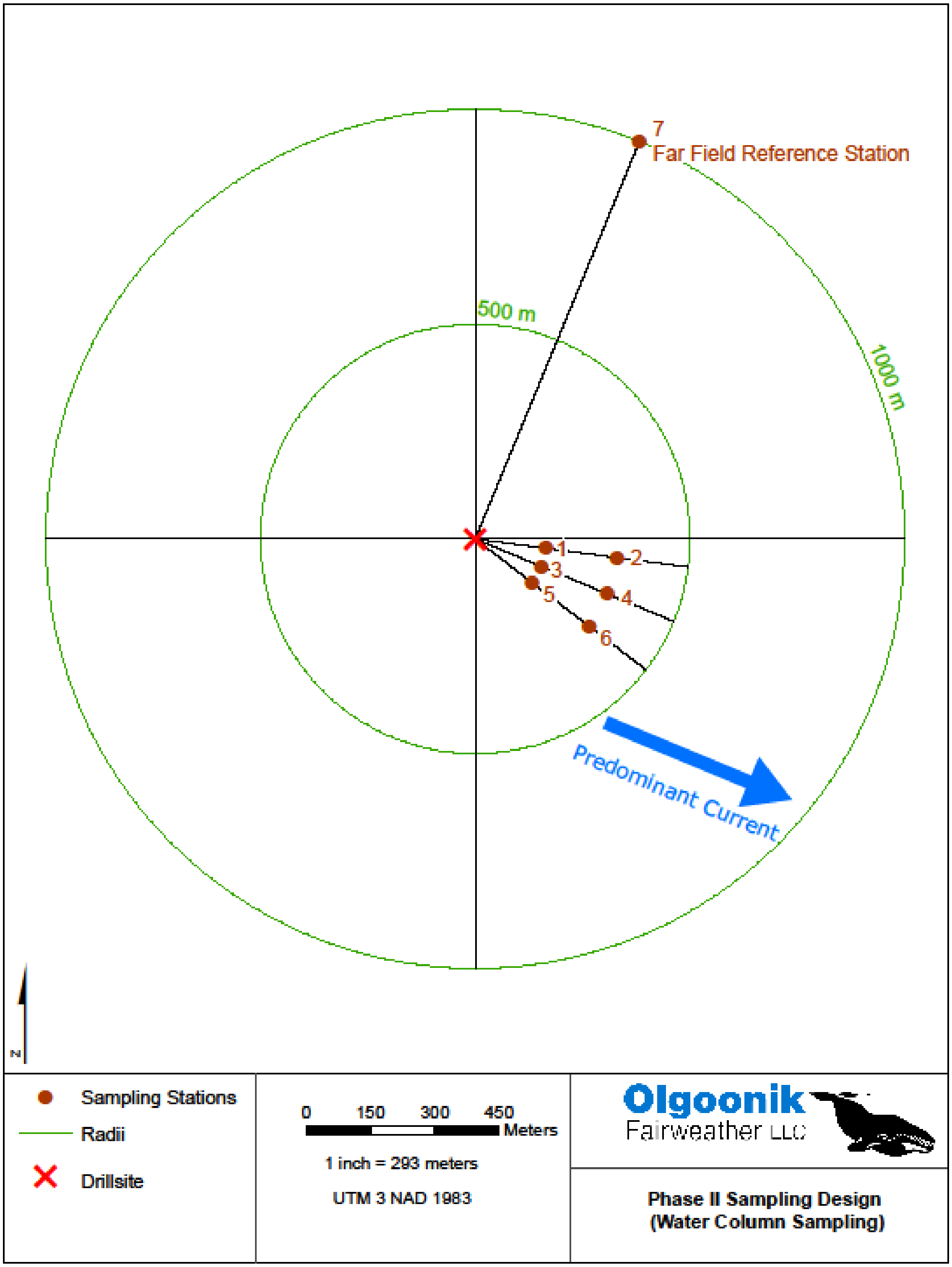

Figure 8: Phase II sampling design (water column sampling).

The CTD unit includes a six-bottle rosette to collect discrete water samples. Samples will be attempted for collection at approximately five different depths in the water column. General target sample depths are approximately 1 m (near-surface), 10 m, 20 m and 30 m below the surface of the water, and 2 m above the bottom of the seafloor. The near-real-time current data from the ADCP and the near real-time water column data from the CTD profiler will be used in an adaptive manner to optimize the location and depth for discrete water sample collection to capture the densest portion of the plume, when possible. Water samples will be analyzed for the following parameters: metals, TSS and organics (volatile organic compounds [VOC], total aromatic hydrocarbons [TAH] including xylenes, total petroleum hydrocarbons [TPH], polycyclic aromatic hydrocarbons [PAH], and saturated hydrocarbons [SHC]). Specific analytes and analytical methods are included in the project-specific QAPP. Turbidity measurements in the water-column will be collected with an OBS and a transmissometer with the CTD attached to the water-sampling rosette. The sensors will be calibrated using in-situ data.

A summary of the Phase II sampling effort is provided in Table 9. The data collected during the Phase II monitoring will be used to assess the location of the plume(s), to refine model inputs, and to help inform the Phase III and IV monitoring efforts. Data from Phase II efforts will also be compared to the chemical analysis results from source samples of the muds and cuttings.

Table 9: Summary of Phase II (sampling water depth may vary depending on in-field measurements of turbidity during plume monitoring, weather conditions, or operational parameters). Total number of samples over all monitoring phases is 105 (35x3).

Sampling Water Depth	Transect Type	Number of Samples		
		Well Timing – Casing	Well Timing – Hydrocarbon Zone	Well Timing – Bulk Muds[1]
1 m below surface	Plume	6	6	6
	Reference	1	1	1
10 m below surface	Plume	6	6	6
	Reference	1	1	1
20 m below surface	Plume	6	6	6
	Reference	1	1	1
30 m below surface	Plume	6	6	6
	Reference	1	1	1
2 m above bottom	Plume	6	6	6
	Reference	1	1	1
Subtotal		**35**	**35**	**35**

[1]if this event occurs

3.2.4.1. Acoustic Doppler Current Profiler

The ADCP will be positioned no more than 2000 m from the drill site. The data on current speed and direction will be relayed in near real-time fashion to the vessel so that the field team can use it to maximize the effectiveness of the Phase II plume-sampling component. The near real-time current data will provide an estimate of the trajectory of the plume in the field, as shown in Figure 8. Discrete water samples will then be collected from the sampling stations.

3.3. Phase III Assessment

Phase III incorporates the post drill sampling conducted as soon as practicable following the cessation of drilling at a well site. In the event that unforeseen circumstances occur preventing the environmental sampling of data immediately after drilling, the EPA will be notified immediately to determine the appropriate course of action.

A four-transect design (N, E, S and W) oriented/rotated approximately 22.5 degrees to the east of north to allow for sampling along the mean current direction, in conjunction with four different radii at 100 m, 250 m, 500 m, and 1000 m from the drill site location, will be used (Figure 9). Note the overlap of the plume-monitoring transect (Figure 8) for Phase II with that of the 112.5 degree transect for the Phase III and IV sampling design. These transect orientations may be modified in the field, depending on observations made during the field effort (e.g., if the Phase II ADCP data indicate a different trajectory for the predominant downstream current direction and/or sediment profile imaging (SPI) and grab samples that indicate the deposition of muds and cuttings).

This approach results in a total of 17 near-field stations, 16 of which result from each intersection of each of the four transects with each of the four different radii. The additional sampling station occurs in the vicinity of the actual drill site location. The orientation of the transects at 22.5 degrees to the east, based on mean current direction, may be modified for Phase III following the plume-monitoring data collected in Phase II if the current directions measured during maximal discharge events are different from those expected, and/or information from sediment grab sampling or SPI images during Phase III. Samples collected during Phase III will consist of sediment for chemical and physical analyses, clam tissues for chemical analysis, and digital SPI photographs of cross-sections of the sediment-water interface (Table 10). Target locations for clam sampling will be stations 3, 7, 11 and 15. Actual locations will be determined in the field based on the availability of clams.

Table 10: Summary of Near-Field[1] Phase III and Phase IV samples slated for collection.

Discipline	Number of Stations	Number of Samples
SPI	17	17[2]
Benthic ecology (Phase IV only)	17	85 (5 reps)
Chemistry – sediments	17	17
Chemistry – biota (clams)	4	4

[1] Far-field samples will be collected at 2-4 stations contemporaneous with the near-field stations and locations will be determined in the field.

[2] Multiple photographs will be taken at each station (plan-view and cross-sectional) to ensure at least one high quality photograph per station.

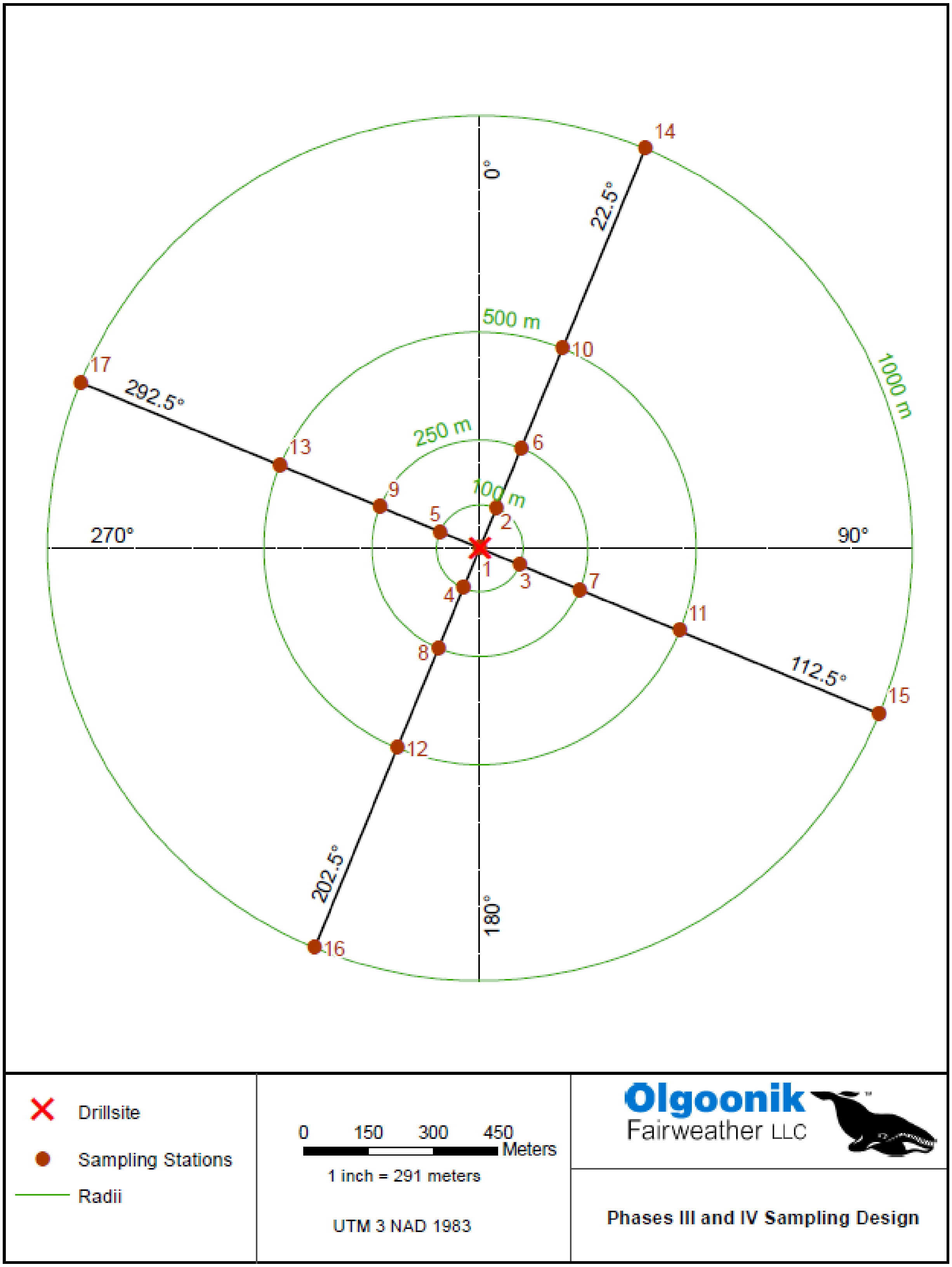

Figure 9: Phases III and IV sampling design (seafloor sampling).

3.3.1. Physical Sea-bottom Survey

Plan-view digital photographs of the seabed and/or profile digital photographs of the sediment–water interface will be obtained with SPI technology and/or other similar technology such as a camera-sled or remotely-operated vehicle (ROV). Images will be assessed to characterize seabed conditions immediately after (as soon as practical) cessation of the drilling operations. Data from the plan-view and/or profile photographs will be used to characterize the spatial extent and depth/thickness of solids deposition as a result of water-based drilling fluids and drill cuttings discharges (Discharge 001) and muds, cuttings, and cement and muds and cuttings at the seabed (Discharges 012 and 013, respectively). In the event that SPI is used, it can facilitate in situ observations at and between benthic-sampling stations, thereby increasing the weight-of-evidence approach's ability to characterize horizontal and vertical impacts on the benthic habitat. SPI technology involves the use of submersible digital camera equipment to penetrate and acquire vertical-profile photographs of the upper 10-20 cm of the seabed sediment that can be analyzed for a variety of physical, chemical and biological parameters. A secondary camera is used to obtain plan-view images of the seabed surface.

During the post-drill survey, photographic data will be collected at each of the 17 near-field stations depicted in Figure 9. Sampling will occur at 16 stations along 4 designated transects at predetermined angles and at 4 concentric radii from the drill site (100 m, 250 m, 500 m and 1000 m), plus at one station in the vicinity of the drill site location.

Additional stations (e.g., a few random sample locations in the downstream direction within the 500 m radii) may be sampled in the drill site area during Phase III to enable more precise delineation of any sediment accumulation resulting from drilling discharges, based on near real-time interpretation of the images obtained in the field. These data may be used to augment conclusions from the Phase II monitoring. Spatial variations in the SPI parameters measured after drilling and at contemporaneous reference stations will be evaluated. Mapped data will be contoured and stations will be ranked with parameters such as organic sediment index (OSI). Areas of the highest and lowest habitat quality or other measurable effects will be depicted graphically.

3.3.2. Sediment Characteristics and Discharge Effects

Sampling will be conducted to evaluate chemical and physical sediment characteristics following drilling activities and to determine the lateral extent of deposition of drilling muds and cuttings. The thickness of the depositions on the seafloor will also be measured via photographic evidence (section 3.3.1) in conjunction with sediment sampling (e.g., van Veen grabs). Based on the knowledge of chemicals associated with drilling operations (and on EPA requirements), the focus for this study will include analysis of organics, metals, total organic carbon (TOC), and grain-size distributions.

Organic contaminants for analysis will include PAH, TPH, SHC and petroleum biomarkers. These compounds are consistent with the list of organic chemicals analyzed in the 2008 characterization study in the Chukchi Sea and the 2012 baseline monitoring at the Burger A drill site allowing for consistent comparison with the baseline sediment-chemistry data. Barite is used as a weighting agent in drilling muds and can be found in concentrations that are elevated above background in the immediate vicinity of drilling operations and in the areas where the discharge plume is deposited. High-purity barite weighting materials will be used containing only trace concentrations of metals (Neff 2005). Metals and hydrocarbons for analysis in sediments are listed in the project-specific QAPP. Sediment chemical concentrations from Phase III will be compared with existing baseline data and with the source samples—muds and cuttings collected during Phase II monitoring—for a comprehensive post-activity evaluation and analysis.

3.3.3. Benthic Community Bioaccumulation Monitoring

Targeted biota for collection for chemical analysis includes clam tissues. Methods of collection will be similar to those used previously in CSESP (Neff 2010) and COMIDA (Dunton et al. 2012). An attempt will be made to collect biota samples at four of the stations where sediment samples and samples for benthic community-structure evaluations are sampled, initially targeting stations along the transect that represents the average current direction. Due to natural patchiness and variability in abundance of organisms, it is particularly challenging to collect adequate sample sizes at a pre-determined station. Locations may change based on the availability of the clams. If clams are not present in adequate numbers at the time of sample, collection of alternative organisms such as amphipods may be attempted. A total of four tissue samples are proposed for collection in the Phase III monitoring.

3.4. Phase IV Assessment

The sampling that occurs for the Phase IV, no later than 15 months after drilling operations cease at a drilling site, monitoring must follow the same sampling design as for the Phase III sampling, as per the NPDES permit. Refer to sections above for discussion of the physical sea-bottom survey, sediment characteristics and discharge effects, and benthic-community bioaccumulation monitoring. The same types of samples will be collected in Phase IV as in Phase III, at approximately the same locations, and collection of the same numbers of samples will be attempted. Benthic community structure sampling and analysis will be added for the Phase IV assessment to measure and assess any potential long-term impacts to the benthic community as a result of exploratory drilling operations.

3.4.1. Physical Sea Bottom Survey

Plan-view digital photographs of the seabed and/or profile digital photographs of the sediment–water interface and will be obtained with SPI technology and/or other similar technology such as a camera-sled or ROV. See discussion in Section 3.3.1 for details.

3.4.2. Benthic Community Structure

Benthic invertebrate communities are a key component in the Chukchi Sea food web, providing benthic–pelagic coupling of organic carbon from sediments to pelagic populations, including many species of marine fishes, birds and mammals. Benthic-feeding marine mammals in the Chukchi Sea include bearded and ringed seals, walruses, gray whales, and occasionally

Bowheads (Bluhm and Gradinger 2008). Walruses migrate through the Chukchi Sea and probably are the main mammalian predator on benthic bivalves and other large benthic invertebrates in the study area (Fay 1982). Nutrients and contaminants bioaccumulated in benthic invertebrates may pass through the Chukchi Sea food web to marine animals valued by subsistence fishers and hunters.

Benthic invertebrates living in sediments (infauna) are excellent indicators of disturbance in the benthos (Boesch and Rosenberg 1981). These sediment-dwelling organisms are either sessile or unable to move large distances (relative to the scale of disturbance events). Thus, they must adjust to environmental change or disappear from the altered environment. Assessments of disturbance events usually focus on change in the community composition of benthic animals due to the differential responses of the animals to stress at individual and community levels. Therefore, benthic invertebrates will be collected for community-composition analysis by methods similar to those used in the CSESP (Blanchard et al. 2010, 2011, In submission a). Photographic documentation will provide a complementary data set to the evaluation of benthic community structure by providing the opportunity to document sediment habitat characteristics and changes in benthic faunal distributions within sediments via digital photography.

3.4.3. Sediment Characteristics and Discharge Effects

Sediment chemical concentrations from Phase IV will be compared with existing baseline data and with the source samples—muds and cuttings collected during Phase II monitoring—for a comprehensive post-activity evaluation and analysis. See discussion in Section 3.3.2 for details.

3.4.4. Benthic Community Bioaccumulation Monitoring

A total of four tissue samples are proposed for collection in the Phase IV monitoring. See discussion in Section 3.3.3 for details.

4. TECHNICAL METHODS

The following includes a summary of the field and laboratory analytical approaches. Brief summaries are presented here. Detailed information can be found in the project-specific QAPP.

4.1. Field Methods

A project-specific QAPP is prepared in conjunction with this EMP document and will be used for the execution of the field program. The QAPP describes the field protocols in detail, including SOPs.

4.1.1. Collection of Phase II Samples

4.1.1.1. Effluent Samples for Toxicity Analysis

Under the Phase II Assessment, effluent samples for toxicity analysis will be collected by grabs of the effluent from six discharges. The effluent samples will be collected from the discharge stream after the last treatment on the drilling rig and before the discharge stream enters the receiving waters. A split of each sample will be collected for chemical and physical analysis as described in the project specific QAPP. Effluent samples for toxicity analysis will be collected in pre-cleaned carboys and kept on ice in coolers under proper chain-of-custody (CoC) procedures, as outlined in the project-specific QAPP associated with this program.

4.1.1.2. Discrete Water Samples (Plume Monitoring)

Plume tracking will be conducted by integrating water column velocity data to predict the plume direction and inform the location of water column profile and discrete sample collection. Water column profiles will be accomplished with a CTD system augmented with OBS and transmissometer sensors for turbidity measurements. The CTD is connected to a rosette water sampler with collects discrete water samples at various depths. Sensor data and discrete water samples will be collected to provide information on water column chemical and physical characteristics within and outside of the plume(s). Discrete water samples will be collected for water-chemistry and water-quality measurements.

Field SOPs and accuracy and precision for the instruments are included in the project-specific QAPP.

4.1.1.3. Muds and Cuttings

Two samples of used WBM and two samples of drill cuttings will be collected during each of the same three periods of the drilling in Phase II that will include plume-monitoring. Sample-collection methods, containers, storage requirements, and holding-time requirements are detailed in the project-specific QAPP. Drilling-mud compositions and monitoring records will be obtained from the drill-rig supervisor as available.

4.1.2. Collection of Phase III and Phase IV Samples

4.1.2.1. Physical Sea-bottom Survey

SPI and/or similar photography techniques will be used to monitor the physical and benthic-infaunal characteristics in surface sediments (upper 10–20 cm) in the study area after exploratory drilling is completed (Phase III). If real-time assessment of the images in the field suggests a steep gradient between sites with noticeable deposition and sites with no visual signs of disturbance, the system will be deployed between the predetermined locations based on best professional judgment in the field, in conjunction with logistical constraints and/or weather conditions. Field SOPs are included in the project-specific QAPP.

4.1.2.2. Benthic Ecology Sampling

Benthic invertebrate sampling will not occur during Phase III monitoring, but will occur, as per permit requirements, in Phase IV no later than 15 months after drilling operations cease at a drilling site. Benthic invertebrates will be sampled with techniques and methods consistent with those used for the CSESP for community ecology (Blanchard et al. 2011). Infauna will be collected with a double van Veen grab and then sieved through a 1.0-mm-mesh screen (the standard for investigations in Alaska with fine sediments). Five replicate samples will be collected at each sampling location. Field SOPs are included in the project-specific QAPP.

4.1.2.3. Sediment Sampling

Sediments will be sampled at 17 near field stations with a double van Veen grab sampler. Sediment samples will be collected from the top 2 cm (i.e., the surficial layer) of sediments. Depending on sediment observations from van Veen grab collections, gravity-core samples also may be collected in the field to obtain truly undisturbed cross-sectional samples of the sediment layer and to provide information on “the areal extent and depth/thickness of solids deposition caused by Discharges 001 and 013.” If collected, the sediment-core samples would be obtained most likely in the immediate vicinity of the drilling location and at the stations located within the downstream 100-m and 250-m concentric radii from the drill site. If evidence exists in the field beyond the 100-m radii of muds or cuttings thicker than expected based on model results, additional core samples may be taken. This decision concerning additional coring will be made at the discretion of the field team leads.

During collection of sediment samples, extreme care will be taken to avoid contact with hydrocarbon sources and any possible metals contamination. For example, samples will be collected from the internal portion of the sample only (i.e., not from the sides that are touching the actual van Veen grab). Field SOPs are included in the project-specific QAPP.

4.1.2.4. Biological Sampling for Bioaccumulation Monitoring

Bivalve (clam) samples will be collected by using a combination of a clam rake and double van Veen grab sampler at the same station. Previous efforts at collecting bivalves and other benthic organisms in the Chukchi Sea during the 2008 CSESP and the 2012 DMP indicated that clams are not obtained with the double van Veen grab sampler in numbers adequate for tissue volumes required for chemical analyses. However, use of a clam rake towed for a few minutes typically allows for collection of numerous bivalves. Because sample size is important for chemical analysis (i.e., having enough sample volume for all analyses), the use of the clam rake is warranted for bivalve collection. Target bivalve species include *Astarte* spp. and *Macoma* spp. If clams are not available at the time of sampling, collection of alternative organisms such as amphipods may be attempted. The species of the bivalves will be determined as best as possible in the field. However, species will be confirmed by taxonomic identification in the Benthic Ecology Task. Field SOPs are included in the project-specific QAPP.

4.2. Laboratory Methods

A project-specific QAPP is prepared in conjunction with this EMP document and will be used for the execution of all laboratory-based analyses. The QAPP describes the analytical requirements in detail, including detailed method descriptions or references (e.g., sample preparation protocols, instrument calibration and sample analysis specifications) and data-quality objectives (e.g., method detection limits, quality assurance [QA]/quality control [QC] program and criteria, data reporting and qualifying scheme). Additionally, the laboratory requirements for the benthic community structure analysis and digital photographic analysis are presented in the QAPP.

4.2.1. Samples for Metals Analysis

Samples of drill cuttings, mud samples, water, sediments, and tissues will be analyzed for a suite of metals. The analyses will be conducted following protocols that have been developed specifically for reliable trace-level analysis of the target metals in complex marine environmental samples. The analytical protocols have been used extensively for baseline characterization and monitoring the potential impact of off-shore oil and gas activities in Alaska, including in the CSESP, COMIDA CAB, Arctic Nearshore Impact Monitoring In Development Area (ANIMIDA) and Continuing Arctic Nearshore Impact Monitoring In Development Area (cANIMIDA) programs.

4.2.1.1. Water

Dissolved water samples collected during drilling activities (Phase II) will be analyzed for a suite of metals, based on a revised list streamlined to reflect each specific metal's toxicity and relevance in drilling muds and cuttings (see Section 3.1.1. and project-specific QAPP). Particulate water samples collected during the plume-monitoring component in Phase II will also be analyzed. Details can be found in the project-specific QAPP.

4.2.1.2. Sediments

Drilling muds and cuttings samples collected during Phase II and sediment samples collected during phases III and IV will be analyzed for a suite of metals. Details can be found in the project-specific QAPP.

4.2.1.3. Tissue

Tissue samples collected during Phases III and IV will be analyzed for a suite metals. Details can be found in the project-specific QAPP.

4.2.2. Samples for Hydrocarbon Analysis

Samples of water, drilling mud, cuttings, sediment and tissues will be analyzed for a suite of VOCs (only in water and muds and cuttings), PAH, petroleum biomarkers (not analyzed in water), TPH and SHC compounds. The analyses will be conducted following protocols that have been developed specifically for reliable trace-level analysis of the target parameters in complex marine environmental samples. The analytical protocols have been used extensively for baseline characterization and monitoring the potential impact of offshore oil and gas activities in Alaska, including in the CSESP, ANIMIDA, and cANIMIDA programs.

4.2.2.1. Water

Water samples collected during Phase II will be extracted for VOC (TAH), PAH, SHC and TPH, following laboratory SOPs (see project-specific QAPP). Detailed analytical methods and additional information are described in the QAPP.

4.2.2.2. Sediment

Samples of drilling muds and cuttings collected during Phase II and sediment samples collected during Phases III and IV will be extracted for VOCs (muds and cuttings only), PAH, SHC, TPH and petroleum biomarkers, following laboratory SOPs. Sediment grain size and TOC content of the sediments will also be determined. Detailed analytical methods and additional relevant information are described in the project-specific QAPP.

4.2.2.3. Tissue

Samples of biological tissues collected during Phases III and IV will be extracted for PAH, SHC and TPH, and petroleum biomarkers following laboratory SOPs. Detailed analytical methods and additional relevant information are described in the project-specific QAPP.

4.2.3. Samples for Benthic Community Structure and Taxonomic Analysis

Taxonomic analysis will be conducted on infaunal invertebrates to determine community composition. Resulting metrics include taxonomic identification, abundance (individuals m^{-2}), and biomass (g m^{-2}). SPI and/or similar technologies (e.g., ROV) and plan-view photography will be analyzed according to methods described by Blake et al. (2009), with results incorporated into the community analyses. QC methods for benthic taxonomic analysis will follow guidelines outlined in Blanchard et al. (2010) adapted from the EPA Environmental Monitoring and Assessment Program (www.epa.gov/emap/html/pubs/docs/groupdocs/estuary/field/labman.html). Detailed methods and additional relevant information are described in the project-specific QAPP.

4.2.4. Analysis of Photographic Images

The range of parameters assessed in the photographic images is presented in the project-specific QAPP. The summarized parameters include: sediment grain size, prism penetration, surface relief, apparent color redox potential discontinuity layer, surface features, subsurface features, successional stage and OSI. Detailed methods and additional relevant information are described in the project-specific QAPP.

4.2.5. Samples for Toxicity Testing

Test methods for conducting the WET testing on specified waste streams are summarized below. Table 11 includes the suite of WET tests required to be performed on the effluents. Also summarized in Table 11 is the method for conducting the suspended particulate phase (SPP) acute toxicity test on drilling fluids (muds) used at the site(s). Additional details can be found in the project-specific QAPP.

Table 11: Summary of WET species.

Marine Chronic Toxicity Tests	Species	Method
Larval Fish 7-Day Larval Survival and Growth Test	Topsmelt (*Atherinops affinis*) or Inland Silverside[1] (*Menidia beryllina*)	EPA/600/R-95/136 EPA-821-R-02-014
Mysid Shrimp 7-Day Larval Survival, Growth, and Fecundity Test	*Americamysis bahia* (Formerly *Mysidopsis bahia*)	EPA-821-R-02-014
Echinoderm Larval Survival and Development Test	Purple Sea Urchin (*Strongylocentrotus purpuratus*) or Sand Dollar (*Dendraster excentricus*)	EPA/600/R-95/136

[1]Menidia beryllina may be used as a substitute for topsmelt

Drilling Fluid SPP Toxicity Tests	Species	Method
Larval Fish 96-Hour Survival	*Americamysis bahia* (Formerly *Mysidopsis bahia*)	40 Code of Federal Regulations (CFR) Part 435 EPA-821-R-11-004 EPA-821-R-02-012

4.2.6. QA/QC

The organizational quality assurance unit (QAU) will remain independent of all work activities. The QAU will monitor the technical components of the project according to existing SOPs to ensure the accuracy, integrity and completeness of the data. Analytical staff members will be responsible for ensuring that sample tracking, sample preparation, and analytical instrument operation all meet QC criteria detailed in the applicable analytical SOPs.

4.2.6.1. Field-Based QA/QC

Standardized field documentation forms will be used to document all sample collection and handling activities, and to track electronically captured data. Field custody of electronic data will be the responsibility of the field survey's chief scientist and/or other responsible party on the vessel. The field custody of the electronic data consists of creating backups of all electronic data generated each day. The label on the backup media will include a survey ID, date, and name of person creating the backup files. Calibration and maintenance procedures for the sensors that will be used are included in the project-specific QAPP. The QAPP also describes the preparation of field QC samples such as field blanks and field duplicates.

4.2.6.2. Laboratory-Based QA/QC

An integral part of laboratory activities, QC lays out methods for maximizing the quality of operations and analyses, provides analysts with metrics about method performance, and aids project managers in identifying and correcting systematic and random problems that can plague laboratory operations.

A routine set of QC samples should accompany each set of samples analyzed at the laboratory. Details can be found in the project-specific QAPP.

The Measurement Quality Objectives (MQOs) for each QC parameter in this project are presented in the project-specific QAPP. Analytical results that do not meet the MQOs will be submitted to and/or reviewed with the project manager for assessment of the potential impact of the results. Affected samples may be reanalyzed at the project manager's discretion. QC sample data that are accepted outside the MQOs will be indicated with the appropriate data qualifier, and the rationale for accepting the analysis will be documented.

4.2.7. Sample Handling, Storage, Shipping and Custody

All samples will be inventoried in a field log book or electronic data acquisition program maintained by the project's chief scientist. All samples will be logged on CoC forms and will be stored in secure areas on the vessel(s) immediately after collection. Sample IDs will be cross-checked against the CoC logs prior to packaging samples in coolers for shipment to laboratories.

Sample integrity and custody will be maintained at all times. Every effort will be made to deliver samples to the laboratories in a timely manner with CoC forms inside each cooler. Established procedures will be followed and maintained throughout collection, packaging and shipping. Fully-executed CoCs documenting the sample receipt will be maintained by the laboratories.

5. REPORTING

5.1. First EMP Report

The first EMP report will be submitted no later than June 1 of the year following drilling site operation cessation. This EMP report will contain a preliminary analysis of site conditions during active drilling operations and an analysis of post-drilling conditions. Additionally, these data will be compared to existing baseline data.

5.2. Second EMP Report

The second EMP report will be submitted no later than June 1 of the year following completion of all drilling site monitoring. As per the NPDES permit, this EMP report will contain:

i. Summary of the results of all stages of environmental monitoring for each EMP phase;
ii. Discussion of how EMP goals and objectives were accomplished;
iii. Analytical test methods used for data analysis;
iv. Description of any impacts of the effluent on observed sediment pollutant concentration, sediment quality, water quality and benthic community;
v. Description of the data, evaluations and determinations with regard to each EMP phase; and
vi. All relevant QA/QC information including, but not limited to, laboratory instrumentation, laboratory procedures, analytical methods detection limits, analytical method precision requirements and sample collection methodology.

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APPENDIX A

Phase I Justification

APPENDIX B

Particulate Modeling Report

APPENDIX C

Thermal Modeling Report